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Evening Meeting.

Monday, February 17th, 1873.

VICE-ADMIRAL A. P. RYDER in the Chair.

NAMES of MEMBERS who joined the Institution between the 4th and the 17th February, 1873.

LIFE.

Robertson-Ross, P., Colonel, Adjut.-Gen. of Militia, Canada.
Herbert, Ivor J. C., Lieut. Gren. Guards.
McHardy, Wallace B., Commander, R.N.

ANNUAL.

Barton, Robert, Captain, R.E.
Carson, James S., Captain Royal Bucks K.O. Militia.
Couchman, E. H., Colonel R.A.
Whitaker, Geo. T., Lieut. 60th Rifles.
Hubbard, A. G., Lieut. 3rd Bucks Rifle Volunteers.
Morshead, A. A., Lieut. 24th Regiment.
Protheroe, M., Capt. Madras Staff Corps.
Mitchell, Hugh H., Lieut. Rifle Brigade.
Farrington, H. D'O., Capt. 73rd Regt.
Stallard, William, Captain 1st Worcester Artillery Volunteers.
Blake, A. M., Lieut. Gren. Guards.
Rowsell, F. W., Esq., Superintendent of Admiralty Contracts.
Wilson, J. C., Captain R.N.
Liebenrood, John, Captain R.N.
Dobbing, Frederic, Ens. 20th Middlesex Rifle Volunteers.
Seymour, Lord Albert C., Lieut. Scots Fusilier Guards.
Lugard, E. J., Lieut. 4th King's Own Royal.
Reidhaven, J. C., Viscount, Lieut. 1st Life Guards.
Malgarini, Fred. L., Lieut. Forfar and Kincardine Artillery Militia.
McLeod, W. C., General.
Brine, Lindesay, Captain R.N.
White, F. B. P., Captain 1st West India Regiment.
Cardew, Frederick, Capt. 82nd Regt.

FLEET EVOLUTIONS AND NAVAL TACTICS.

By Commander CYPRIAN A. G. BRIDGE, R.N.

ADMIRAL RYDER AND GENTLEMEN—

By invitation of the Council of our Institution, I have come here this evening to read a paper on a subject which I believe to be most important. Unhappily it has by no means attracted the attention which, as a matter so closely concerning the efficiency of the Navy, it justly merits. I must, at the very outset, confess my own inability to add much to your knowledge of it; but I hope some good may result from my venturing to bring it under your notice. Though there are not wanting Officers who have bestowed upon NAVAL TACTICS much thought and patient study; still, it cannot be denied, that the consideration of

the art, has not occupied the minds of the great body of Naval Officers in general. I hope that the study of it will soon become the common pursuit of the many, rather than, as now, the special occupation of the few. I may remind you how you yourself, Sir (who first turned my own thoughts in its direction), gave it, years ago, an ample share of your consideration; and I may also select from the short list of students of tactics the names of Captain Goodenough, Commander William Dawson, and Commander Fisher. Here, in this theatre, on more than one occasion, and in those official labours of his, which will long leave their mark upon the Service, has Captain Colomb employed his talents as a lecturer, and his graceful pen in endeavouring to teach us, his brother Officers, that which, I fear, too many of us have been but slow to learn. These names do not of course exhaust the list of those who have studied the art of modern NAVAL TACTICS; but they are the names of those with whose labours I am personally familiar, and to whom, I gratefully acknowledge, I am under no small obligation.

I have given to this paper a two-fold title, because I shall try to point out in it the distinction between the evolutionary and the tactical manœuvres of fleets; and also the connection existing between them. The former are the bases and foundations of the latter; the indispensable preliminaries without which tactics could scarcely be devised, or, even if devised, employed with advantage. "Those who know any-"thing of the Navy," says our oldest authority, the Jesuit, Hoste, "will not doubt that the *art of Naval evolutions* is absolutely necessary "to it; since that art is nothing else than the manner of regulating all "the movements of a fleet. Without it, a fleet resembles a force of "savages, who do without order, all that caprice inspires, or chance "suggests. Without it an Admiral can make only very imperfect use "of his fleet, whether it be to oppose the enemy in the proper way, or "to cut his line, double on him, avoid him, bring him to action, or chase "him; for all these things require that the Admiral should be the mov-"ing spirit of his fleet as the mind is of the various members of the "body." "If," says Admiral Gregory Boutakov, "*only three ships* have "to sail in company, they must have rules based upon the laws of their "own movements, and the knowledge of these same laws is undoubtedly "necessary to each ship even though she manœuvre alone." Sir Charles Ekins mentions Lord Howe and Lord St. Vincent as among "the few British Admirals who, in former days, took any particular "pleasure in exercising the fleet in the different evolutions:" with what result let "the glorious first of June," and the 14th of February, 1797, testify. It is by frequent practice in evolutionary movements, that we are enabled to perform tactical manœuvres speedily and well. "*Pide la Tactica Naval*," says the old Spanish writer Mazaredo Salazar, a name not undistinguished in the naval annals of Spain, "*Pide la Tactica Naval un continuo exercicio; porque no bastará saberla* "*para practicarla bien.*" Which I may translate, "The art of Naval "Tactics requires continual evolutionary exercise; for merely knowing "its rules will not suffice in order to practice it correctly."

The great object of FLEET EVOLUTIONS therefore being to lay a

foundation for NAVAL TACTICS, there are not wanting smaller, but by no means unimportant, ones as well. These may be laid down as being to discover—

1st. The capabilities of each ship as a manœuvring unit;

2nd. The possibility of manœuvring or of handling collectively, any aggregation of such units;

3rd. The best formations and movements for navigation, for preparation for battle, and for actual combat; and also, I may add, to give to Officers facility and confidence in handling a squadron by frequent practice of the various movements.

As specimens of the different classes of what are usually considered evolutionary manœuvres, I may instance, as of the first, the "figure of eight evolution," or that which many Officers will remember as having been practised by direction of Admiral Lord Clarence Paget by the ships of the Mediterranean squadron, and which is too well known to need description here. By it, undoubtedly, the handiness and turning power, the comparative value of different angles of helm at different rates of speed, and the time necessary to describe certain arcs of the circle of turning were rendered familiar to the Officers of each ship, and the knowledge thus gained, must have greatly smoothed the difficulties of the general squadron evolutions.

I may next give, as of the second class, such movements as "altering course," "tacking in succession," "changing position of columns," and "changing formations;" all of which had to be first devised and then assiduously practised before the possibility of handling successfully large collections of ships was properly established.

To the third class belong "orders of sailing," "formations" of various kinds, "line of battle," "line ahead;" and also whatever new manœuvres, recent naval invention has rendered necessary.

Not only do I think that repeated exercise in all such evolutions is necessary to give us the power of imparting strength and flexibility to our fleet-formations; but I also feel convinced that it is by such exercise alone, that we can ever hope to discover what manœuvres will be of most advantage to us if we are ever to fight another general action at sea. Therefore I am of opinion that all evolutionary manœuvres should be devised with this object—which includes all that I have hitherto stated—in view, viz., to make our Officers perfect in the art of handling squadrons and single ships, and to discover—what we have not yet hit upon—that which is to take the place of the old "line of battle," now so completely passed away.

For this purpose, I suggest that all fleet-movements be divided into two main divisions—those intended simply for the purpose of training Officers in manœuvring, which might be called "evolutionary;" and those which it is probable we might be called upon to adopt in action, to which we might correctly apply the designation "tactical." The former class could not well be too numerous. I would not give up one evolution in our present admirable signal-book, of the evolutionary portion of which, I am always glad to have an opportunity of expressing my humble admiration. To those who advocate a reduction in the number of movements it contains—and many of those who do so are

worthy of all respect—I would say with Admiral Boutakov, that it is "our duty to exhibit every formation which, it seems possible can be "employed with advantage under the various circumstances, leaving "to the Admirals—according to the degree of instruction and prac- "tice of their subordinates—to select those which seem to them most "fitting, and to omit those which may appear to them superfluous."

If such a division of our evolutionary scheme be made, we may then conduct the exercises of our squadrons on a systematic plan. We may begin with what is simple and elementary, and, through the various stages of instruction, go up to what is more complicated and more difficult. By the courtesy of my friend Captain FitzRoy, of Her Majesty's ship "Minotaur," I was favoured, some months ago, with a sight of an admirable scheme of successive evolutionary exercises which he had himself drawn up, and which seemed to me exactly to meet the requirements of a hastily collected fleet, such as even ours must often be. He proposed first to let the ships carry out separately such exercises as may be necessary to give their Officers a correct knowledge of their manœuvring capabilities; next to let the "subdivisions" (I use the word in its present technical sense) manœuvre together; and then to proceed to the general evolutionary exercises. Now, no one, I think, who has observed the difference between the manœuvring of a ship which has just joined one of our ironclad squadrons, and that of the same ship after a few days' practice with her consorts, can have any doubt of the great advantage of some plan of this kind. The different facts obtained in each period of instruction—such as coefficients of speed, requisite amount of helm-angle at different speeds, &c.—should be collected and circulated, as *data* for evolutionary calculations, among the ships of the fleet. This would tend to render homogeneous and compact a fleet, which might otherwise continue only a "fortuitous concourse" of individual vessels. Thus, I also believe, we should succeed in making our FLEET EVOLUTIONS appear to be what they really are, viz., a system of drill and instruction.

I would even give the system the *name* of "drill" or "exercise." Why should not all our evolutionary, and some of our action-signals be codified in a separate *Handbook of Evolutions and Tactics*, which might take its place by the side of the *Manual of Gunnery* and the *Field Exercise Book?* The evolutionary signals have already been separately printed, and a limited number of the books containing them have been issued "confidentially" to the ships; but the work is a mere transcript of a certain number of pages of the Signal Book. Until something of this kind is done, I fear we shall never carry out our annual manœuvres on anything like a definite system, nor is it likely that much instruction will be derived from them.

Supposing our fleet movements to be divided as I propose, practice in the evolutionary, would of course precede that in the tactical portion. The latter should be made to resemble, as closely as our present want of experience would permit, what would take place in actual war. In the first place we should have to consider (and this, as its adoption would inevitably become imperatively necessary whenever

war might be imminent, deserves early and serious thought) the "order of sailing" when likely to meet the enemy. When we reflect how short a time will hereafter elapse between the moment when two fleets sight one another, and that at which it will be possible for them to be effectively engaged, we shall readily understand that this is a question which urgently demands a speedy settlement. The consideration just alluded to—the short interval between sighting the enemy, and action—irresistibly points to the conclusion that our "order of sailing" in time of war must not depart very widely from our formation for battle. As no ship yet devised, can be kept at all times perfectly ready for fighting without some preparation, however minute, we must take steps to gain time. We must have early notice of the enemy's presence, of his whereabouts, of his condition, and of his probable intentions. We must, in fact, patrol—far to the front and flanks—the surrounding sea. We must cover our fleet with a flying squadron of swift ships, the presence of which is not necessary to form the "order of battle." It seems quite unquestionable that we can settle many important points connected with this matter even in the midst of the profoundest peace, provided only that we happen—as we fortunately often do happen—to have a fleet collected together.

How far we are able to construct a system of true tactics for fleets from the experiences of peaceful cruises is, of course, not very definitely certain. From the course of recent history, it follows that we must work at such construction to a great extent in the dark. The rapidity with which science has supplied to us the materials for war, has enormously outstripped the actual warlike demand. The requirements of naval war have been, as it were, forestalled, and we shall have to undertake an almost entirely new work with perfectly new and hitherto untried tools. We are so entirely without experience of actual fighting under the new conditions; we embark on such a vast ocean of doubt whenever we try to forecast the future of naval warfare, that one may be almost forgiven for despairing of ever sighting some friendly light by which to shape one's course. The difficulties in our way should however tempt us to proceed. It is not we naval Officers alone who are checked and discouraged in attempts to pierce the veil which hangs before, and hides from view, that which has yet to be discovered. Our great natural philosopher, Professor Tyndall, speaking of some of the difficulties which beset his experimental investigation of the diathermancy of atmospheric air, says*:—"It is this which daunts the "experimenter; it is this preliminary fight with the entanglements of "a subject, so dark, so doubtful, so uncheering—without any know-"ledge whether the conflict is to lead to anything worth possessing—"which renders discovery difficult and rare." Let his eminent triumphs over such obstacles, encourage us to persevere. Fortunately it happens that in the difficult path of tactical discovery, all have not been disheartened by the apparently insurmountable obstacles that beset it. "It seems at first sight probable," says Captain Colomb,†

* "Heat as a Mode of Motion," third edition, p. 304.

† "The Attack and Defence of Fleets," Part 2, No. LXVI of the Journal of this Institution.

"that no such thing as rule or law can be evolved except from the "facts of experiment in war. It is therefore readily assumed that "naval strategy is not yet in a condition to be made a subject of study." But he goes on to say—"I trust I have shown in former papers "that so far from being the vague conglomerate of conflicting opinion "generally supposed, a very superficial analysis recovers many points "of absolute certainty round which theories may safely revolve, or, at "the very least, gives encouragement to persevere." I cannot refrain from here offering my cordial thanks to the utterer of those cheering sentences.

The preparation of my lecture was almost completed, and it wanted but little to put it definitely into the form in which I am now presenting it to you, when I received the January number of *Naval Science*. The title of an article on "Naval Autumn Manœuvres" naturally—engaged as I had been—attracted my attention, and I lost no time in reading it. My perusal of it filled me both with admiration and despair: admiration for the masterly manner in which the writer had treated his subject, and despair of my ever being able to follow, even remotely, in his footsteps. I felt the wind completely taken out of my sails, and by one too who had evidently a far better right to it than I had. I have no hesitation in qualifying that paper as a "memorable" one; and I assert with confidence that had it been on a subject connected with our military, as distinguished from our naval, forces, every newspaper in England would have deemed its contents only too well worthy of discussion. I will go farther, and will say that the whole country would have rung with the facts that it disclosed. Who will attempt to deny the truth of this assertion?—

"It must be first pointed out that while the autumn manœuvres of "the land forces represent the assured results of military science, and "develop in a gigantic game the latest and most approved maxims "of a theory constantly readjusted by appeals to fact, the naval "autumn manœuvres at present represent no more than a vague "groping after something definite at which it is hoped we may arrive "at a future time."—*Naval Science*, No. 4, p. 2.

And this, be it remembered, is said of the fleet of a country of which friends assert and enemies admit that it is the greatest naval Power in the world.

We must, then, make up our minds to evolve from the evolutionary system, which the industry and patient thought of some of our most enlightened Officers have given us, a real system of tactics. We must make more certain and more plain the distinction between true tactics and mere manœuvres, and also the close connection between them, which makes one the basis and foundation of the other. The use of steam has rendered now not only possible but easy, that which some years ago would have been altogether out of reach. "The movements of "steam fleets," says Sir Howard Douglas,* "may, like those of armies, "be conducted on tactical principles best adapted to the *end of all pre-* "*liminary manœuvres*—the formation for battle in the most simple,

* "Naval Warfare with Steam," p. 87.

"speedy, and precise manner." Our inquiry therefore should be—How far can we make those preliminary movements, which we have already adopted, of service should we ever be called upon to fight an enemy's fleet?

I shall, with your permission, endeavour to foreshadow what, in my opinion, will not improbably be the aspect of a future general action at sea. I shall do so diffidently, and even doubtingly, for—

"—— modest doubt is called
The beacon of the wise;"

and it would be dangerous folly to assume that any particularly imagined future is rigidly certain. In the first place, as I have before said, a very short interval will elapse between the moment at which two fleets sight each other and that at which they will begin to fight. At whatever speed they may be proceeding, the fact of the enemy's heaving in sight will be of itself sufficient to cause every ship at once to make ready to increase her's to the utmost when necessary. In whatever formation the hostile squadrons may have been navigating, they will be pretty sure to try and get into one which will enable them to present the bow of every vessel to the enemy. The actual shape of such formation may vary greatly: both fleets may be in "line abreast," or in "line ahead," or in detached groups, or in a close phalanx; or one may be in one formation, and the other in another. Both fleets also may have every component ship in the "line of battle," if I may use that convenient, if not perfectly correct term; or both may have a first line and a reserve; or one may have detached a portion of its whole strength as a reserve, whilst the other may still keep all together. However they may be drawn up, I think that—if both are willing to fight—something like this will take place:—

Both will continue to approach one another at a greater or less speed; that of about 8 knots, I am inclined to believe, will be the most usual. As they approach every gun, which from its position and angle of training can do so with any chance of effect, will most likely be fired at the enemy. As they arrive in closer proximity this bow-fire will become at length ineffectual, and the respective Captains will be disinclined to keep the fore parts of their ships enveloped in clouds of smoke, so it will cease. Now will come the doubly anxious moment of seeking to ram one's antagonist; to avoid being rammed by her; to steer clear of her towed torpedo; and to plant one's own torpedo conveniently under her water-line. About this moment, too, the ships of that fleet which is not in "line abreast" may fire one or both converged broadsides; the fleet that is so formed will be precluded from having recourse to that, probably still advantageous, proceeding. In the early stage of an action, whilst heads are still cool and formations still to a certain extent kept, I venture to think no great damage will be done on either side. I do not mean that no ship will be hit by shot, or even that none will be destroyed by either ram or torpedo. What I do mean is that no fleet, as a whole, will, in my opinion, suffer any serious diminution of its strength at first. The two, I expect, will pass through one another to a great extent intact, till there shall arrive the time which shall be the

crucial test of the value of the evolutionary practice of peaceful times. The two fleets will have to reform and prepare for a second encounter, much resembling that which has just taken place. To paraphrase the remark of a distinguished General,* "Now is the time for the reserve "squadron." Picture to yourselves the effect, moral as well as material, of a well-ordered column of fresh ships bearing down at superior speed upon a group of vessels endeavouring to re-form after passing through an encounter such as I have attempted to describe. Should any vessel have received no other damage than the disabling of her machinery, she will yet be at the mercy of any that, still possessing the power of motion, may be ordered to cannonade or ram her; and, refusing to strike, may, as she lies motionless, be conveniently disposed of by one of Mr. Whitehead's torpedoes, which may be not inaptly termed the successors of the old fire-ships.

Believing, as I think there is fair ground for believing, that something like this will be the course of a general action in future, I may venture to suggest what I deem the best mode of arranging a fleet to engage in it and the proper steps to be taken to carry it to a successful issue. I have no desire to dogmatize; indeed I have not the knowledge sufficient to lay down what may be received as an inflexible law. It is impossible, just at present at least, to bring forward conclusive proof of the superiority of one formation, or of one manœuvre, over any other. The art of tactics is not invariable but ever changing, though always owning allegiance to the eternal laws of strategy. So that, remembering what will very likely be expected from the ships of a fleet in action and the means with which they are supplied for fighting, all that can be usefully done here is to state the advantages and disadvantages of any particular formation or any particular manœuvre. That some one formation is the best for battle—not under all circumstances, but most generally—I do not doubt in the least. My friend, Commander Fisher, in a most interesting little pamphlet, quotes the opinion of a distinguished French Admiral, that "the armour-"plated navy recognizes no fundamental order of battle." Now, no one can have a greater respect than I have for the gallant Navy of France, our worthiest antagonist on the sea; but I cannot avoid the conviction that that sentence does not contain an article of orthodox tactical belief. If by it we are to understand that no undeviating rule for forming a fleet for action should be laid down, then I agree with it; but only then. Depend upon it, Sir Howard Douglas was nearer the truth when he said that the formation for battle in the most "speedy and *precise* manner" was the true end of all preliminary manœuvres.

I hold, then, that we must have some definitely arranged *set of formations* from which to select the one best adapted to the particular circumstances in which our fleet may happen to be placed. One formation appears to me to possess more advantages than all others, that the *peloton*-formation in echelon. The germ of the *peloton* I find is contained in a book of so old a date as the Italian translation of Ramatuelle's "*Tactique Navale*," published at Naples in 1813.

* "Voici le beau moment pour la cavalerie."

Ramatuelle was a Frenchman, and, according to Sir Charles Ekins, was the great authority in tactics in France during the "old war." His countrymen have since elaborated the idea of the *peloton*. His, if I remember right, was composed of four ships. The late Count Bouet-Willaumez proposed a formation with three, and the official *tactique* of the French Navy, if I am rightly informed, contains rules for the formation with both numbers. This attempt to devise a formation for action falls within the true province of the tactician; and it is only after numerous evolutionary experiments, that he can feel any hope of lighting upon that which is best.

All iron-clad ships—to a far greater degree than those of any older type—are constructed so as to be able to deliver a heavy *bow-fire*. Some Officers even think that all broadside-ports should be so constructed as to admit of no fire *abaft* the beam and greatly increased arcs of training *before* the beam. A fleet going into action in "line-ahead" would reduce its bow-fire to that of a single ship, and the number of prows ready for instant attack, to one. Most of our heaviest ships, and those too of other powers, are devised to fire *broadsides*. A fleet in "line abreast" can only fire a broadside from one set of guns in each of two ships on its extreme flanks, and, in fact, only when it is outflanked. A fleet in "bow- or quarter-line" can fire its guns ahead and on the broadside as well, but its rear ships seem to me to lack support. Consequently I think we must adopt an "order of battle" which shall combine as many of the advantages, with as few of the defects, of the formations just enumerated. This appears to me to be found in the echelon of *pelotons*.

I believe I am correct in ascribing the important modification of the original equi-angular *peloton*, known as the "scalene-triangle," to Sir Thomas Symonds and Captain Goodenough. A fleet formed of such *pelotons* in echelon, would at all events have these advantages—no bow gun and no broadside-gun would be masked by a friendly vessel; no consort's hull would intervene between the prow of any ship and the enemy; a slight change, of course, would convert the "order" into "indented line ahead, or abreast;" each leader has a support and a reserve; rallying points are sufficiently numerous for one to be always pretty near after the disorder of a *melée;* and, I think, it enables a fleet to reform in it rapidly. Do not suppose that I am so wedded to this formation for action that I would wish to see its adoption authoritatively imposed upon all Flag Officers in time of war. I assure you I am not. I have no "pet" order-of-battle. I have brought this forward now, chiefly as an illustration of the method by which tactical formations may be evolved from fleet evolutions. On a former occasion and in another place,* I ventured to bring the advantages of this formation to the notice of an assemblage of my brother Officers. My object, then as now, was chiefly to draw attention to the too-neglected subject of NAVAL TACTICS. I was careful then to assert my conviction, "that the actual requirements of battle can never be

* At Plymouth, May 27th, 1872, before the members of the Plymouth United Service Institution.

"provided for in the drill-book or the signal-book." And if I now repeat much of what I then adduced, it is because I still long to obtain more thought and study for this great subject.

My efforts then, such as they were, were kindly seconded by many friends. I soon found myself engaged in a correspondence sufficiently extensive to show that the number of silent students of NAVAL TACTICS, though small, is by no means unimportant. The letter of one of my correspondents contained some remarks so valuable and striking, that I shall make no apology for quoting them:—

"I think that it would be of service if certain *orders* of attack were "invariably accompanied by corresponding *developments* of attack."

Again—

"This strictly tactical movement (that of bringing overwhelming 'force upon some portion of the enemy's fleet) should not be left to "chance or signal, but should be one of the direct logical sequences "of the order of attack adopted; such order of attack being arranged "on sight of the enemy's formation, being governed by it, and calcu-"lated to take the best advantage of it."

These passages occur in a communication which I received from a young Officer, Lieutenant H. Grenfell, whose capacious grasp of the true principles of the ART at so early a period of his service, augurs well for the future tactical efficiency of our Navy, in which, I believe, he will not stand alone.

I shall not occupy your time long in explaining how I believe that FLEET EVOLUTIONS during peace may be turned to account in ascertaining and establishing TACTICAL FORMATIONS and MANŒUVRES for adoption in war. That has been so admirably done in the article in *Naval Science*, to which I have already made allusion, that to those who have read it, I could tell little that they would not have already learned. But one main purpose of this lecture would be unfulfilled if I were not to do so, though briefly, before I finish. One great step towards such a consummation has already been taken. By the practice of the last two or three years, the assemblage annually of two or more squadrons combined under a single chief, has become a recognised naval institution. Up to the present moment we have taken advantage of this collection of the mightiest fleets which the world has ever seen, solely to execute a few drill manœuvres, for no other reason, apparently, than because they are to be found in the signal-book. It is not surprising that even to those who aided in carrying them out, they seemed terribly uninteresting and unmeaning. It would be the same with all drill, if it were to end merely as drill. Turning to the right- or left-about, would be the dreariest occupation ever invented, if it were to lead to nothing but pivotting on the heels. No one would ever take kindly to the motions of spunging and loading, if he did not feel sure that some day he would have to ram home real powder and shot.

I remember when I was one of the gunnery students in the "Excellent"—an *alma mater* for whom I shall always have the greatest veneration and regard—we used to joke each other upon being made to learn in our musketry drill, that "all a soldier's other instruction "in marching and manœuvring can do no more than place him in the

"best possible position for using his weapon with effect." Like many other things which I learnt in the "Excellent," and which in my contemptuous ignorance I then thought useless to a sailor, that short sentence has proved to me a most valuable acquisition. It has at least enabled me to estimate aright the tactical importance of mere evolutionary exercise. From the summer cruises of our "combined fleets" we ought to obtain the knowledge how "to use our weapons (of whatever kind) with effect."

Why should we not take some formation—say, for the sake of argument, that which I have proposed—and forming our fleet in it, advance against a line of targets, previously laid out, supposed to represent an enemy's line? Place the targets in any "order" you please (they might be moored in the mouth of the Channel), we should at least be able to form some estimate of the value of bow-fire when advancing. We might also arrive at some knowledge of the relative handiness of different formations for attack. We might learn, too, how far the smoke from guns or funnels would interfere with the exact maintenance of any given formation. We might also find out which would be the best station for the leaders. I believe we might go further than this, and that we might make one part of the Fleet operate against the other. We might discover how many shots could be fired from a carefully-laid bow-gun when two fleets were rapidly approaching. We might teach ourselves a great deal about the proper rate of speed for action. And we might, I venture to think, gain much practical experience of the offensive and defensive efficiency of the Harvey torpedo in fleet actions; for the ships of each fleet might, in their mock engagement, tow a "dummy" on either side, provided with a few grains of some explosive as a "blowing charge," merely to mark its action. The tactics of the ram, of course, we could not attempt in a fleet, but we might do so with steam-launches, either towing two buoys to represent a ship (as Captain Goodenough has suggested in a letter in my possession), or specially protected against the injuries of collision; or we might, as the Russians have done, try the same thing with small gunboats. Nor is this all that we might do with our Fleet in peace to prepare us for the very object of our existence as naval Officers, viz., the perfecting of our efficiency in war. We might, as has been suggested to me by Captain Wilson of Her Majesty's ship "Impregnable," pit one division of our Fleet against another as blockaders and blockaded, and thus illustrate what the history of the Crimean and Franco-German contests shows would be no unusual occupation of ships in war.

I believe I can easily prove that there is nothing new, nothing that will cause great expense, and nothing dangerous to the ships in the proposals I have brought forward. Unfortunately, it is not only such objections as those that have to be met by anyone who desires to advance the tactical efficiency of the Service. Some amongst us there are, who deem all evolutionary practice useless; who, relying upon their own undoubted skill and heaven-sent gift (for such it is) of deftly handling ships and squadrons, decry the instruction of others less gifted than themselves; who, because the extraordinary and original genius of a great naval architect has given us ships which are the admiration and

the models of the navies of the world, think that with their guns and *rams* we must, in the old headlong, inconsiderate way, bear down all that dare to stand against us. I wish that those who think thus, would study the tactical history of the Navy a little. In it they would find, how in our "dark age" of NAVAL TACTICS, the British Fleet won few victories, and no very glorious ones; and how, till the era of true tactical knowledge dawned, the actions in which it was engaged were, as a rule, indecisive or partial. They would find how patient a student of tactics was even our great Nelson, who spent many an hour in pondering over all the possible circumstances of battle, and whose favourite occupation it was to listen while the chaplain read to him from Clerk of Eldin's *Essay*. They should remember Captain Colomb's apophthegm, that "the brave man had better be intelligently brave while he is about it." Surely to them we may apply the words which Shakespeare puts into the mouth of Ulysses; for they indeed it is, who—

> "Count wisdom as no member of the war;
> Fore-stall pre-science, and esteem no act
> But that of hand: the still and mental parts—
> That do contrive how many hands shall strike
> When fitness calls them on; and know, by measure
> Of their observant toil, the enemies' weight,—
> Why, this hath not a finger's dignity:
> They call this—bed-work, mappery, closet-war;
> So that the ram that batters down the wall,
> For the great swing and rudeness of his poize,
> They place before his hand that made the engine,
> Or those, that with the fine-ness of their souls,
> By reason guide his execution."—
>
> *Troilus and Cress.*, act i, sc. 3.

Yet it was by the aid of such "closet-war" that Rodney restored the prestige of the British Navy; and in our day we have seen how the "observant toil" of Von Moltke and his assistants has ended in shaping the destinies of Europe for many years to come.

It will be easy to estimate roughly the expense of such exercises as those I suggest. Put the number of ships in the Fleet at twelve. Let them—devoting Saturday and Sunday to the two neighbour virtues of cleanliness and godliness—manœuvre for five days in each of two consecutive weeks, and for four hours a-day. That would give a total of forty hours' exercise. Two tons' extra expenditure of coal per hour for each of the twelve ships would amount to nine hundred and sixty tons, which, at thirty shillings* per ton, would cost less than fifteen hundred pounds. At this rate I fancy the sea-fights at Admiralty Patch or Middle Deep would necessitate but a small fraction of the expenditure caused by the battles of Codford Bridge or the Hog's Back.

All naval history proves the wisdom of some such exercise. There is nothing new in it. In one of the oldest-recorded sea-fights, that at Ladé, the defeat of the Ionians by the Persians was mainly caused by the Samians' undisciplined impatience of the tactical instruction of

* Since this was written the price of coals has enormously increased; still it may be hoped that it will have fallen about the months of July or August.

the Phocæan admiral, Dionysius. Any one who cares to follow up the subject, will find in that admirable newspaper, the *New York Army and Navy Journal*, a series of essays—now in course of publication—on ancient and mediæval sea-fights by a distinguished and accomplished Officer of the American Navy, Captain Foxhall Parker. They will be found to be not only papers of considerable literary merit, but also highly interesting as showing the unbroken continuity of tactical knowledge and practice in former days. In the least scientific age of our own naval power, the proceedings of our Fleets, such as they were, indicated the same careful preparation. "It is difficult, almost im-" possible," says Mr. Laughton, in a remarkable essay on *The Sovereignty of the Sea*,* which every naval Officer should read, "to under-" stand how ships of the clumsy form and rig, which was the neces-" sity of the age, could manœuvre at all * * * but, if there be " any truth in history, the English ships did manœuvre, and that, too, " in some species of formation." In the *Calendar of State Papers*, I find an abstract of a letter from Sir William Clerke to Secretary Williamson, dated "Royal Charles," The Downs, May 30th, 1666, in which the writer says, "They have been *modelling* the Fleet." We who have so often seen hoiste[illegible] the signal to "Take down in writing the *organisa-*" *tion* of the Fleet," will readily understand what that means.

The proposal, therefore, to improve our tactical knowledge is one sanctioned by appeals to experience, is not rendered impossible by great additional expense, and is recommended by every principle of policy to our adoption. At the present moment, NAVAL TACTICS can be scarcely said to exist. What have we done to advance the art since the introduction of steam? Take the few lines of tactical suggestions prefixed to the action-signals of our present signal-book. Is there—with the single exception of the one which does acknowledge the existence of steam-power—any which would not have been as suitable to the days of the Armada as to our own? One indeed does breathe something like a faint inspiration of obsolete tactical principles. I cannot, of course, quote the words of the signal-book here; but I may say that in the volume (clxiv) of the *Calendar of State Papers* already mentioned, will be found notice of a letter from Prince Rupert to the King, in which, after asserting his "zeal for the Service" (for the art of blowing one's own trumpet was as well understood in the Prince's day as in our own), he says, "The *additional orders* show his anxiety " to follow instructions." He encloses a copy of these *orders* from which I make the following extract:—

"Additional fighting instructions; being orders for forming the line of battle in " case of attack or defence, and in different conditions of the wind. The Com-" manders are forbidden, on pain of death, *to fire over any of their own ships.*"

The milder manners of our own age have softened the penalty; we have hardly improved upon the instructions. What we require is a set of tactical maxims or rules, drawn up in accordance with the requirements of modern sea-warfare: not necessarily containing absolutely

* "Fortnightly Review," August 1st, 1866, p. 724.

imperative injunctions, but laying down in clear, unmistakable terms, the broad principles of NAVAL TACTICS.

Gentlemen, I have already taken up too much of your time in what, I fear, has been but a dreary explanation of a dreary, although an important, subject. If I have been tedious, it was because I wished to persist in trying to arouse the feeling that the British Navy is bound to show the way in this, as in other paths, to the navies of the world.* Standing here beneath the very roof that covers so many relics of our heroic past, I cannot but remember that we are the holders of a glorious heritage; we are the representatives and professional descendants of the gallant spirits who won for our country the sovereignty of the seas. True, in the zenith of her power she voluntarily abandoned the right to it; and "it is now," to use the words of one† who, in the study of naval history, has been my master and guide, "only a "memory of those past times, when an unrestrained barter of cotton "and sour wine was not supposed to be all that was necessary for the "advantage of a nation."‡ The titular sovereignty having been thus freely laid aside, it is more than ever incumbent on us to fortify and secure the real and virtual power. Those of us who attempt to do so, will find that there are many difficulties to oppose, many obstacles to overcome. The record of past achievements should cheer us on, for it is truly "a stirring sound." We do not indeed, in our attempts to improve the tactical efficiency of the Navy (to borrow another phrase from the great historian,§ whose words I have just quoted), "fight beneath the cold shade of those above us!" Our contest is waged beneath a chiller shadow; that of popular indifference and of too-frequent professional apathy and neglect.

Captain GOODENOUGH, R.N.: I rise, merely to ask Captain Bridge to correct a small point in his exceedingly interesting and very suggestive paper. I would ask him to correct what he states with reference to the formation of ships in *pelotons* of scalene-triangles, which he said was due to Sir Thomas Symonds and myself. It was due to Sir Thomas Symonds alone, who thought of it, and worked it out. I can only say I think in certain cases it might be made great use of, because while you have two ships in the position of your attack and of your support, you have the third at a free distance as your reserve ship.

On the general subject of "Naval Tactics," I think we cannot do better in a time of great uncertainty, than to heap up as many propositions and as many ideas of tactics as possible, and then proceed by trials in our squadrons at sea, to demolish those which are shown to be utterly useless.

There is one thing which I think both the Lecturer and Captain Colomb—who are more than students of the art of naval tactics,—might do for us, and that is to define a few of the terms which are used in maritime warfare; for instance, such terms as "evolution," "tactics," "manœuvres," "strategy." Before we can set out on an examination of "naval tactics;" before a useful paper can be written such as it is pro-

* "—— and if now and then I shall seem to warm into a style somewhat too stilted and pompous, let me be excused for my subject's sake."—*C. Kingsley.*

† Mr. J. K. Laughton, R.N., in "Fortnightly Review," *loc. cit.*

‡ A naval Officer's opinion upon freedom of trade, or any other politico-economical question, is not likely to be thought of much weight; but I may say that, though no one probably goes farther than myself in advocacy of the most unfettered liberty of commerce, I yet agree with our ancestors that it is "*not all that is necessary*" to a nation.—C. A. G. B.

§ Sir William Napier.

posed shall be written by persons who are asked to compete for the prize offered by the Junior Naval Professional Association, we should have these four terms properly defined.

Captain COLOMB, R.N.: I have some difficulty in addressing the meeting, because I am not accustomed to receive what I must call the undeserved praise that has been given to my little endeavours to put this question on a right footing. Possibly there may have been some policy on the part of the Lecturer in beginning with a tribute to my small labours, because when a man is so flattered at the beginning, he is not very ready to offer hostile criticism farther on. But I think, whatever might have been said, my feeling on following the paper, as I have done, word by word, would have been the same, namely, that we have had a remarkably clear, concise, and able exposition of the state of "naval tactics" at the present moment. I am not aware that I have ever read, certainly I have never listened to, so complete a description in a short space, of the points that must be attended to in dealing with this question of "naval-tactics."

I take first the question of exercise. The Lecturer draws from the Italian translation of the French work which he has quoted, these words:—"The art of naval tactics requires continual evolutionary exercise; for merely knowing its rules will not suffice in order to practise it correctly." I am sure there never were truer words said as to the practice of naval tactics. I have had in my time to take boats out for drill; I have drilled models on the table, and I suppose I may be allowed to know a little of the present system of tactics in the Navy; but when I see what I have learned from books, or from the manœuvring of boats, put into practice in a fleet, I feel I am dealing with something totally different. The distances you have to deal with are so great, the question of smoke, the difficulty of making out signals, the difficulty of conveying the Admiral's wishes along the line from ship to are so unexpected, that you feel at once the truth of that saying.

The Lecturer next passed to the question of classifying "naval evolutions," and I almost entirely agree with the classification that he has put forward, viz., first, to take the single ship as to what she can do; then to come to manœuvring collectively in small aggregations, as I suppose he put it; and next, after you have arrived at some satisfactory platform on that point, to pass to more complicated manœuvres.

Captain Goodenough has spoken on a point very nearly analogous to that, on the question of the definition of terms; and that is a most important one. We have been obliged to construct for the Navy as we stand at present, a terminology which has gone a certain way, but is still very defective. We want a much closer definition of the terms we use. Captain Goodenough mentioned some, but there are many others. For instance, you want a term to refer the mind at once to the relative position of ships in their columns, and you want a second term to refer the mind at once to the relative position of the columns in a fleet. You may have ships in quarter-line, and you may also have the columns in quarter-line. The ships in each column may be in line-abreast, in line-ahead, or in quarter-line. The columns in the Fleet may also be in line-ahead, line-abreast, or quarter-line. (Captain BRIDGES: In echelon.) Echelon, as you call it; I call it quarter-line, because it is the recognised term. You have at present no term to express these two things; you mix them together. You say the Fleet is in a certain "formation," when you do not convey by that term the fact that the ships in their columns are disposed in one particular way, and that the columns in the Fleet are disposed, perhaps, in another particular way. Terms are wanted readily to express these conditions.

The Lecturer next comes to the question of exercise, and he says: "Not only do I think that repeated exercise in all such evolutions is necessary to give us the power of imparting strength and flexibility to our fleet-formations; but I also feel convinced that it is by such exercise alone that we can ever hope to discover what manœuvres will be of most advantage to us if we are ever to fight another general action at sea." There again is a distinct and clear point. It is only by constant experiment, and, as Captain Goodenough has stated the excision of those movements and formations, which are found to be useless, that you can ever make any progress.

The Lecturer speaks strongly about the separation of drill from tactics, and that is a point on which I also am very strong. Your drill is quite a different thing from your tactics; it is a matter of exercising the nerve and brain, and teaching Officers

by more complicated manœuvres to be confident, when the simple manœuvre comes which is to take them into battle. He next says the way to separate drill from tactics is to have a drill book for our Fleets. It is not more than a few days since that I wrote pointing out, that that was the only solution of the question at the present time. You cannot be perpetually altering the official book, which you might have to depend upon at any moment in war. But if you have a separate drill-book, which is to be used for drill and for experiment only, you may make it as large as you like. You may introduce any sort of manœuvre that anybody proposes, and you may give the Fleet the power of working with this drill-book, for experiment and drill, and you may make it a feeder to the recognised official tactics of the Navy. That is to say, by having a drill-book, so to speak, not official, you may, as your knowledge increases, and your experience enables you to detect what is right and what is wrong, recognise with certainty in your official "signal-book," those movements which you desire to retain, and you may put out of sight those which you do not desire to retain.

The next point that I wish to draw attention to, is analogous: "We must, "then, make up our minds to evolve from the evolutionary system, which the industry "and patient thought of some of our most enlightened Officers have given us, a real "system of tactics. We must make more certain and more plain, the distinction "between true tactics and mere manœuvres, and also the close connection between "them, which makes one the basis and foundation of the other." I have nothing to add to these words, and have only to express my agreement with them.

The Lecturer draws attention to the very short interval of time that would "elapse between the moment at which two fleets sight each other, and that at which "they will begin to fight." A brother Officer of mine meeting me the other day, said, "I do not agree with you in your views of tactics. You like a great deal of manœuvring." I said, "I am very sorry for that. I am afraid you have not quite gathered what I have endeavoured to convey," because I am satisfied with the Lecturer, that unless your mind is made up beforehand, unless your "sailing for-"mation," as he puts it, is very closely analogous to your fighting formation, you will find yourself in a difficulty. There will be no time to make dispositions in the event of meeting a fleet; your dispositions must be made before hand, your sailing formation must be such as will at least enable you to pass to your fighting formation, in the shortest possible time. Signals and manœuvres are, I take it, quite out of the question.

Then the lecturer proceeds to describe what he supposes will be the course of a naval action. He puts the speed at about eight knots. I have always put it at ten knots myself, because that has seemed to me the general idea of the Navy; but if I were to express my private opinion, I should say it would more likely be eight knots than ten knots. Then the lecturer goes on to point out that he believes the "fleets will in the first instance pass through one another intact." Now they say naval Officers never agree, but I must say I do agree with him on that point. I believe the fleets would pass virtually intact, that there would be, as he describes it, a re-formation, and that that fleet which re-forms quickest and is most ready to begin again, stands a very good chance of winning the day.

Now we come to the "peloton," which is a very disputed point. The peloton, I believe, was omitted from the original edition of the signal book, because it was said—and I agreed, I think, that we knew nothing about it—we did not know what its real value was. It afterwards crept into the signal book, because it was said to possess a certain value. But the system of manœuvring by pelotons is quite a distinct method of manœuvring a fleet. In the case of a peloton, you take your three ships or your four ships in a group, and you consider and treat that group as a single ship. Theoretically, the ships in a group do not alter their formation. In the group of three for instance, you give the leader the charge of that group; you give the starboard ship we will say a position close by on the starboard quarter; you give the port ship a position distant on the port quarter. The orders those ships have, are in all cases to maintain those positions, roughly of course, but still their rallying points are those. Well now, a fleet arranged in groups or pelotons in this way, becomes very mobile, inasmuch as you manœuvre the group as though it were a single ship. If you have a fleet of twelve ships, your signals would be the same as if you had only

a column of four ships, you do not trouble anybody, but the leaders of the groups, and it is supposed that the men who are leading each group are picked men, capable men, who exercise their command over the small group. The theoretical effect is that when the group of three is used, you reduce the chances of error by two-thirds; that is to say, if you make your signal, whatever it may be, to nine individual ships, some of those individual ships may go wrong, the signal may be mistaken; but if you address your signal to three of those ships—the other ships having merely particular stations to keep—you run much less chance of confusion and error. I am not prepared to say that that is the system of tactics of the future, but I am prepared to say that it is a matter that should be, like every other question of naval tactics, thoroughly worked out, because as the lecturer said, and I quite agree with him, we are not on at all sure ground, we want experiment to guide us. I think these are all the points that I need advert to. I must congratulate Captain Bridge on the very excellent lecture he has given us.

Commander W. Dawson, R.N.: The naval Service must be congratulated that an Officer should be still left on the active-list capable of producing such an able and eloquent paper as that we have heard to-night; and who has also the moral courage to study and to form opinions upon a professional subject, and to express those opinions publicly. Moral courage on professional subjects is not so very plentiful in the Navy but that we must observe with gratification that, notwithstanding recent legislation, an Officer is found with anything to lose, who is possessed of that risky qualification. I gather from the paper that the Navy still holds to the idea that there is "a royal road to learning," some instinctive way by which Officers can acquire knowledge and skill in the profession without practising it. When landsmen are particularly ignorant on any subject, they say they are "at sea" on that subject, and I presume that as to tactical exercises, it is in that sense that the Navy is "at sea." Perhaps the fleet is only in that sense "at sea," that is to say, "not at home" in tactical manœuvres, that there has been a want of intelligent direction at head-quarters on this subject. One of the first things required in order that tactical manœuvres may be fairly tested is, the appointment of a standing "tactical committee" to meet in London, say for the three winter months in every year, for the purpose of collecting and collating what has been done by the squadrons on each of the nine foreign stations in the course of the previous twelve months, to elucidate tactics at sea; and of suggesting what ought to be done by each of the nine squadrons in the succeeding twelve months: an Experimental or Training Committee if you choose to call it so, on naval tactics, consisting of thoughtful Officers, capable of learning themselves and of forming intelligent opinions upon difficult and novel matters. If this was a military question, instead of a naval one, we should have half a dozen committees sitting every year, each charged with the examination of a separate subdivision of the subject, and the matter would be exhausted by crucial experiments carried out in all sorts of ways under all possible conditions; but being a naval subject, it is otherwise.

It is deplorable that notwithstanding the annual expenditure of so many millions sterling upon the Navy, and the crying necessity for careful investigation arising out of the recent introduction of so many novelties in ships, propulsion, turning-apparatus, guns, armour, rams and torpedoes, we should still have in a discussion on tactics to deal solely with opinions, and that we should have no facts; for not a single fact has been brought before us to night. A few facts have, it is true, been brought from Russia and France, and other foreign navies, but none from the British Navy. Why is this? Why, without burning a single extra ton of coals, it would be possible to chronicle the movements which are being performed at this very moment. Every week there are ships going out of Portsmouth, Plymouth, and Sheerness, for the purpose of trying their turning powers and speed at the measured mile. Why cannot the Steam Reserve Officers be directed to chronicle the angles of helm required to turn each of those ships, in one common tactical half-circle, at one uniform rate of speed, say eight knots, as well as the minimum half-circle at highest speed? Why cannot some persons of intelligence be employed to put the results together and tabulate them so that when ships meet together, the Admiral of the Fleet may be able to turn to that table, and say, "That ship is so long, she cannot re-"verse her course without describing such and such a half-circle; the whole

"fleet must be guided by that ship's turning power," and the Captain of every other ship present should know what is the helm-angle which will cause his vessel to describe a similar half-circle similar in point of speed—we want the information which already exists, tabulated and circulated—but which it is nobody's business to tabulate and circulate—for the guidance not only of tacticians, but of fleets. I am one of those who go in very strongly for extreme simplicity in all essential tactical manœuvres. By that I am to be understood as drawing a wide distinction between those manœuvres which are simply requisite, in order to exercise the nerve and judgment of individuals, and to enable them to gain experience and confidence not only in their own powers, but in the capabilities of their respective vessels, and those other manœuvres which are to be practised in the presence of the enemy. Speaking of the latter part of our duty, I think the tactics for future naval battles cannot be too simple. We must look forward to future war-fleets being at the outset of a great maritime struggle, composed very much as old war fleets were, viz., with Officers placed suddenly in command who have not heretofore had the opportunity of serving in evolutionary fleets. These Captains will have under them junior Officers who have also had no experience of the kind; and they will have half-disciplined and partially trained crews, who will occupy a great deal of the personal attention of the Commanding Officers, diverting their minds from the novel study of fleet-tactics. For these reasons, manœuvres that are absolutely essential for handling a fleet in the presence of an enemy, should be made as simple and as few as it is possible to devise. There appear to me to be two modes of approaching an enemy: first with double columns, in line ahead; and secondly, with a more or less extended front, presenting indented lines of one form or another, varying in character with every change of course. But which of these should be selected for the approach, will depend very much upon the formation of the enemy. If the enemy were coming up in two columns in line ahead, it would be a waste of power to mask your own batteries by attacking that enemy in a very extended line. The enemy would in fact concentrate his whole force upon two ships in width of your extended line, so that, in that case, the enemy's formation would compel the adoption on your part of a small front and great depth, such as would be obtained by some formation like that of "double-columns in line ahead." The question is, whether even if the enemy be formed in an extended line, you would not do better by concentrating the whole of your force upon the smallest portion of his line, and this would be effected by attacking him in "double columns in line ahead." An extended formation, whether in echellon or otherwise, would be chiefly useful against a retiring or pursuing foe. If the attack upon a willing enemy be made in extended line, that formation should be adopted which will admit of the maximum of flexibility, with the least confusion in frequent and rapid changes of course, and that can be most readily reversed after each charge. This, and not the best theoretical formation for the delivery of artillery fire, seems the governing condition. This if arranged so as not to mask each other's fire on one course, will do so on any considerable alteration of course. Artillery fire will not be very effective in the rapid movements which will take place when one fleet charges another. I have no particularly great faith in our gunnery practice at present. It is capable of much improvement; but even when it is so improved, you cannot expect many useful hits to proceed from bow fire, supposing both fleets to be approaching each other at great speed. Of course, in case of a retiring enemy, bow fire would become a very important element, and the more indented and extended your line, the better. I am not one of those who think it may not sometimes be necessary for tactical purposes to show your stern to the enemy. It may be necessary when you pass through the line to be able to fire abaft the beam and astern as well as a-head. Nor can we always expect to be strong enough to be the attacking fleet; and stern fire is essential in a running fight. In dealing with tactical manœuvres in the presence of an enemy, we must not forget that a number of unarmoured ships will be in company. If the enemy be allowed to cut off the ironclads from all the unarmoured vessels, it would not be his policy to leave those small ships unmolested. And when the ironclads have passed through the enemy's line, he will be in the middle of the fleet, and have the choice of attacking the unarmoured division without turning round or of turning to resume the charge. But he would hardly risk turning his

fleet round if a wooden squadron were ready to avail themselves of the necessary confusion; and he might prefer to continue his course and attempt the destruction of the unarmoured and reserve divisions. We have not heard to-night very much on the subject of rams. I am glad to see that Captain Bridge accepts the idea that each ship, armoured or unarmoured, would materially protect herself against rams by the employment of the towed torpedo as a defensive weapon. There is a vast difference between the employment of that weapon defensively and offensively. Offensively, no doubt a great deal of skill and manœuvring with special vessels of high speed and quick turning power is necessary; but defensively, when towing it merely from the fore part of the ship for the purpose of keeping off rams, no such exceptional skill is needful, and I believe that that will turn out to be the most important use of that weapon in fleet actions. Whenever divergent torpedoes, diverging 80 to 100 yards on each beam, are towed from the bows of armed ships, other vessels will hesitate to ram, and ramming will be reduced to a minimum. Of course ramming would not be altogether abandoned for this cause, as the divergent torpedo requires high speed, and any derangement to the ship's machinery would deprive her of this protection. Even then, however, outrigger torpedoes might be rigged out if a ram approached. Still a daring Officer would not throw away a good opportunity of ramming a moving ship on the bow: but when it came to ramming a hostile ship abaft the beam, the presence of a divergent torpedo would make it a rather dangerous proceeding.

The whole subject of naval tactics is, at present, one of opinion, without any basis of experimental data; but there is one point to which I should like to draw attention, namely, the absurdly "confidential" character of the tactical drill-book. A reason not yet touched upon, why the drill-book should be circulated independently of the "general signal-book," is that the majority of the Officers afloat have never had the opportunity of serving in squadrons. Not only have they thus no practical acquaintance with fleet work, but they labour so hard when on full pay, that they have neither strength nor time for professional duties. When they come on shore on promotion for a temporary period of half-pay, they have probably more leisure than they ever had in their lives. I met a young Captain in the country the other day studying mangold wurtzels and turnips. On asking him why he had given up the profession, he indignantly replied that he had not done so, but that his present occupations were dictated by his extreme anxiety to obtain a command and to advance in his profession. He was afraid if he lived anywhere in the sight of naval subjects, he might be induced to study the different changes that take place in the present day, and thus to form opinions on professional subjects; the expression of which might militate against his obtaining a command when his turn came, and that thus professional ruin might, under recent legislation, attend his professional studies. He had therefore retired to the country, so that being supposed to have no professional opinions he might when his turn came, not be passed over and ostracised from the profession he dearly loved, but have a chance of serving again. Now I say that Officers temporarily on half-pay might profit very much and the public service profit also by their enhanced knowledge, if they had the opportunity of studying the tactical drill-book during their enforced leisure on shore. The Junior Naval Professional Association has come forward most patriotically with an offer of fifty guineas for an Essay on the Tactics of Future Naval Battles. But every Officer is precluded from competing for that Prize Essay unless he happens to be on full pay, for the pressing reason that the existing tactical drill-book, which is an essential element of study for such a competition, is withheld from him, though it is doubtless furnished to every foreign embassy in London. The book is not to be found in the library of this Institution, because it is included in a "confidential" volume called the "General Signal Book." But if the drill-book or Manual of Tactical Science recognised by the Admiralty, was not sealed up from British Naval Officers as a "confidential" publication, then Officers temporarily on half-pay would be at liberty to employ their leisure time in preparing themselves for future commands by close and careful study of tactical questions; and even old discarded Officers like myself might be allowed the satisfaction of earning our retired pittance by employing our brains to the good of our country, and the opportunity of showing that even though we are prematurely discarded, we have still

some brains left, and some intelligent love for that noble profession which, under whatever adverse conditions, we cannot but desire to see honoring the proud heritage handed down to it, by maintaining its high position as the chief defence to our island dominion.

Captain WHEATLEY, R.N. :—In the few remarks I purpose making, I shall confine myself entirely to tactics. In the first place, before we can do anything with tactics we must have ships that can manœuvre alike. I have mentioned before in this Institution that I am for bow-fire. I also consider that with line-abreast you get a greater power of formation, whatever the formation of the enemy may be. One thing has not been mentioned, and that is the power we have in steamers which makes them even superior to a body of men on shore—I mean the power of stern-movement. Suppose, instead of advancing at ten knots an hour, you back astern. You will then have more time to see what your guns will do. You will not go ten knots, of course, but you will be better able to see what your guns will do. The enemy coming on at ten knots, will get into greater disorder than you will. If he comes on in scalene formation, your outer ships bring their guns to bear upon his bow and upon only two or three ships. Actions at sea have always been gained by leaving some few of the enemy's ships completely free. In the first instance you can bring a greater power to bear on the leading ships by backing astern. Supposing he comes on in line-abreast, you may very easily withdraw one wing and bring your line at right angles to your first formation, forming on the weather flank ship. The enemy will pass in front of you ; he will be covered by the smoke, and you bring the strongest part and the greater number of your guns against his weakest side. And if he comes on in two divisions or two lines ahead, you have only to part in the middle and bring the same formation to bear on his line as he passes—you bring your bow guns to bear on his broadside.

The CHAIRMAN : Before I give your thanks to Captain Bridge, which I am sure you will allow me to do, I should like to make a few remarks. Captain Wheatley has recommended to your notice a novel method of attacking the enemy, and that is by going *astern*. But it must be remembered that screw ships going astern must inevitably go in one direction, viz., stem to the wind—that is the only way in which we can induce screw steamers to move—and therefore that species of manœuvring will not do for the purpose of receiving the attack of an enemy.

Captain Bridge has alluded to a pleasant cruise we had together some few years ago in the Channel Fleet, when he was my Flag Lieutenant, a service relationship to which I always look back with great satisfaction. He spoke of the method of teaching tactics and practising them in gunboats and steam launches. Undoubtedly, as Captain Colomb says, there is a wide distinction between such practice and real practice with full sized vessels. Unfortunately we have very little of either. I do not think we have ever had any real practice with gunboats, though certainly that would be better than nothing, when we remember how few Officers serve for a short time, if at all, in a fleet. I believe the Russians carry out gunboat exercise of fleet evolutions perseveringly. I am not quite sure whether the French do so, but the Russians certainly do. They protect the bow of the gunboat with some sort of buffer, and then the cleverness of the young Lieutenants is tested by their attempting to ram one another, and I am told, although it is hardly probable, that there is one Russian Lieutenant who proved so expert that he has never yet been rammed.

There is one subject upon which Captain Bridge has not touched, and I dare say he avoided doing so because we shall have a paper on this subject before the Session breaks up, viz., on the "Naval War Game." It occurred to me some time ago that while the Army are enjoying their tournaments over the military "war game," nobody has yet brought before the world any attempt to have a naval "war game." There is a gentleman in the Fleet, I may mention his name, Lieutenant Castle, of the "Hercules," who is endeavouring to prepare a paper for us on that subject, and probably we may have a naval war game and naval tournaments in this theatre this year as there are military tournaments now at Woolwich.

We have heard remarks from several persons about the "confidential" drill book. I have long held the opinion that confidential reports, whether reports of Officers' characters, or drill books, or whatever they may be, are a myth. I do not believe in

confidential reports; they generally leak out. If you attempt to maintain a secret in a professional matter, you first of all suggest to persons interested that it is very important, and then they consider it their bounden duty to attempt to obtain possession of it, and thus you tempt them to pursue unworthy means of getting information; you tempt foreigners to get the information from persons in subordinate positions who may be able to give them the information. I do not say that they always succeed, but the temptation is most mischievous. The whole thing, I believe, is a great mistake from beginning to end. I shall be very glad to see, as far as possible, all confidential work of this kind done away with; it is, as a general rule, perfectly inoperative, and the sooner it is given up, the better. Besides which, the confidential book, whether a "torpedo" book or a drill book, or whatever it may be, who is it that never sees that book, and who is it that always has a copy in his possession? The persons who never see it are the persons who ought to see it and study it, viz., the Officers on ships or on shore, who in the latter case can well spend their spare time in studying it. And who are the persons sure to have a copy of it? Why they are the Officers of other nations who take an interest in the question, and I am bound to say have a copy of these books in their possession now, at the present moment, supplied by their Governments, and study them as often as they wish. Therefore I contend the whole question of "confidential" books should be reconsidered. I know as a matter of fact that the Russian Admiral had a copy of the naval signals of every nation, the English book in manuscript. Mention was made of the shortness of time that would elapse after ships came in sight of one another before they were at close quarters. It is well that we should remember what that shortness of time is. Eight miles an hour is the speed which Captain Bridge has given, and which Captain Colomb endorsed. Anybody can understand that if the fleets are four miles apart and steaming towards one another at that speed, in fifteen minutes they will be alongside of one another. Now fifteen minutes is a very short time to change a position, and therefore it is now more than ever incumbent on those who command fleets, to keep their ships in a good position for entering into action, and also for all Officers to be especially wide awake. I trust that we have a signal now, as the French have, which would enable ships that are in some other formation to change it by passing rapidly, without going through any tortuous manœuvre, into the position in which it may be necessary to place them for action, the only rule being that when one ship has to pass near another, the junior Captain passes under the stern of a Captain senior to himself. No other direction is given but that, and they are allowed to get into their places as soon as they can. I do not say that is a manœuvre that ought to be practised ordinarily, but there are occasions when such a manœuvre would be of importance. I see Captain Colomb shakes his head. (Captain COLOMB: I do not shake my head with reference to the usefulness of the manœuvre, but only because of the fact that we have no such signal). With regard to the peloton. Captain Bridge was pleased to say I introduced it into the Fleet. Really Captain Colomb introduced it, because Captain Colomb in his first lecture on Naval Tactics first drew our attention to the peloton, and spoke of it as a formation adopted by the French Navy. When I was in the Channel Fleet the other day, I brought it under the attention of Sir Thomas Symonds, and it has been considered and introduced into our tactical formation. But Captain Colomb is the real introducer of it, after the French, of course, to whom we owe it. One advantage of the peloton is this, and one which no doubt was included in Captain Colomb's view, and that is, that in the smoke of battle we shall not see our Admiral's signals; they will be utterly lost sight of. You will see the ship next you, and you may see the next but one, but as for the Admiral, four or five or more spaces off, you may know nothing about him except that you may hear his guns occasionally. There is therefore that advantage in the peloton, that the two ships attached to the leading ship have some chance of following somebody's motions, and of sticking to and aiding some ship, whereas if the peloton or some similar formation is not adopted, they will all be looking for the Admiral's signals. The peloton, therefore, is one of the best formations we can have. I do not know whether it has been adopted in our Army. It has been adopted a long time ago in the French Army, and I believe great importance is attached to it. Three men hang together and support one another in action.

I do not think too much can be said about the importance of bow fire in our ships. In the later designs of ships we are paying more and more attention to it. There is enormous importance to be attached to it. The stern fire is, of course, almost as important as the bow fire, and is also being paid more attention to.

With regard to the summer cruises, I concur with what has been said, that we do not get enough out of our summer cruises. I suppose there is some practical difficulty in the way, otherwise we should; but certainly the suggestions made in the paper in "Naval Science," now endorsed by Captain Bridge, are exceedingly valuable; and we may trust and hope that in our next squadron-manœuvres the very valuable suggestions may be carried out.

I am sure you will allow me to return your thanks to Captain Bridge for his interesting and instructive lecture.

Captain BRIDGE: Captain Goodenough was kind enough to correct me in attributing to him, in conjunction with Sir Thomas Symonds, the merit of having introduced that very important modification of the peloton-formation into the service. I have always understood that in the service it has been attributed, if not entirely, at all events in great measure to him, and I had the less hesitation in inserting in my paper what I read to you. But of all the remarks that have been made to-night, nothing seems to me to have been so important as that made by Captain Goodenough, in which he insisted upon the necessity for a definition of such words as "tactics," "evolutions," "manœuvres," and "strategy." That is where, in my study of the subject, I have found that we are so hopelessly and altogether adrift, and until that is done—and it must be done either by authority or under the shelter of authority—we may almost as well leave the study of tactics altogether on one side.

Nothing, I am sure, can give me greater pleasure than to find that Captain Colomb and myself agree with regard to the speed at which fleets are likely to engage. That is immensely important, and we cannot think too often of it, for if we arrive at some satisfactory conclusion about it, we have not fought half the battle, but nine-tenths of the battle.

Captain Dawson has made this evening—as I find from the Journals of this Institution he has been in the habit of making—very many valuable remarks upon the paper. He speaks in the first place of the want of moral courage of naval Officers. I do not think that that is exactly a fair charge to bring against Officers who are now serving, and I think it is—not that Captain Dawson has unfairly charged us with anything—but he has rather mistaken what is the real state of affairs. We were talking of definitions just now, and I think he has defined the thing inaccurately; he has applied the term "want of moral courage" to that which is not want of moral courage, but that which is modesty; and I can claim no credit on this score of modesty. There are many Officers, certainly several of my own acquaintance, who are not only as able, but very much better able than I am, to come and address such a meeting as this, but their modesty has restrained them. It is no want of moral courage, but they feel that young Officers ought not to put themselves into such a position as that which I, from, perhaps, not moral courage, but forwardness, have done.

To go on to another thing, which is, perhaps, less abstract and more concrete than what I have just said. Commander Dawson suggests that committees should sit to inquire into questions of this sort. I quite agree with him. I think it is a great misfortune that we have nothing of this sort. We have, as he says, few facts, but many opinions, and we can only get facts—(it seems to me to be a defect in the English mind)—we can only get facts by cross-examination. We must have a sort of Tichborne trial before we can get at anything like the truth. He also made a remark about ships going out of harbour, and the great advantage that might accrue to the service from the record of the angles of helm necessary for turning a certain number of points. Now that I inserted in the body of my lecture, and I ought to have said, and if it ever appears in the Journal of this Institution, I shall take the liberty of adding, as a note, that that suggestion I owe entirely to Captain Dawson himself; he was one of those correspondents to whom I allude who were kind enough to assist me when I was working at this subject. That was one of the things which he suggested, a suggestion which has come from no other quarter that I am aware of, but it is a most valuable one. A table of the helm-angles of the different ships

would take its place on the bridge of the different vessels in the squadron, by the side of those tables of deviation which you and I, Sir, know so well.

He also said, when we were likely to commence war we should find that we had to make use in the Service of a large number of Officers who had not been lately serving, and who were quite ignorant of the latest ideas. (Captain DAWSON: Officers who had not been serving in fleets, and were ignorant of fleet manœuvres. There are numbers of Officers who never served in a fleet). I think that seems to corroborate my view, that we ought to have a set of maxims and evolutionary data, and that kind of thing which would enable a man to learn a great deal more than merely reading over a table, or a book.

With regard to "stern fire," I do not think, as I believe some Officers do, that stern-fire is nearly, if not quite useless, but I am inclined to think the value of stern-fire, after passing through an enemy's fleet, would not be very great. I do not think it would be advisable to do much towards altering our heavily armoured ships in the stern from what they are at present. I am also very glad to see for the first time as far as I know since its introduction into the Service, that Captain Dawson spoke of the sea-torpedo as being most valuable as a defensive weapon. Ever since I arrived at any knowledge of what it really was, that has always been my opinion, that it is a *defensive*, and not an *offensive* weapon; and I think the sooner we make up our minds to that the better. If it will take the place in great measure of so many more inches of iron plating, so much the better. I had a conversation on this subject with Captain Goodenough the last time I was in London, and he made a remark which sank very deeply into my mind, and which is so valuable that I make no apology for repeating it now, and that was, although a captain may depend on the defensive value of the Harvey torpedo towed alongside as a protection against ramming, yet you are likely to meet with such an antagonist as Admiral Tegethoff, the Napoleon of the sea, as I believe him to have been, who broke through all rules,—and it would be a rule that you are not to ram a ship with torpedo towing alongside,—and when he found an enemy passing across his hawse, would ram him, torpedo or no torpedo.

Captain Dawson also mentioned a friend of his who has turned his attention to planting mangold wurtzels, and I am sure in these days, when beef costs I do not know how much a pound, and coal anything you like a ton, any man who does so deserves well of his country. At the same time I think it ought to be remembered that Rodney was what in his day was the equivalent of a retired Officer before he commanded the Fleet in the West Indies. Therefore we yet look to those Officers on the retired list to do much to uphold the honour of the Service.

You, Sir, have so exactly expressed my own opinion with regard to the stern movements that Captain Wheatley spoke of, that I do not know that I could say anything more about them. I do not know how far that invention of Captain Bremner's that was lately exhibited here might obviate anything of that sort, but still I am inclined to think it would be, to say the least of it, a very hazardous manœuvre to put sternway on your ship when an enemy with an armoured bow was 200 yards off.

You mentioned the "War-game." I hope I am in order in saying I brought the materials up here by request of yourself and of my friend Lieutenant Castle, and deposited them in the library of this Institution, where they are at present. That signal that you spoke of that exists in the French service, for going astern of another ship, is one which unfortunately we have not got in our Service. There are very many things which we may learn and have learnt from the French Navy, and I think we might also take over that with great advantage to the Service.

NOTE.—As I stated in my reply to the remarks of the several Officers who addressed the meeting at the conclusion of the reading of my paper, the valuable suggestion as to collecting data for evolutionary purposes from the performances of the various ships emanates from Captain Dawson, and from him alone. I regret I cannot put my hand upon the interesting letter in which he conveyed the suggestion to me, or I should take the liberty of quoting his own words.—C.A.G.B.

CAPTAIN J. G. GOODENOUGH, R.N., in the Chair.

EXTRACTS FROM THE FOUR LAST CHAPTERS OF ADMIRAL JURIEN DE LA GRAVIÈRE'S BOOK ENTITLED "LA MARINE D'AUJOURDHUI."

Admiral RYDER: It was arranged that on the termination of Captain Bridge's paper, I should read some extracts from the four last chapters of Admiral Jurien de la Gravière's work on the "Navy of to-day."* I propose, however, considering the lateness of the hour, merely to read those remarks which touch on "tactics." The paper will be printed and appear in the Journal, and I would recommend all those who are interested in knowing what so distinguished a Frenchman thinks on such a question, carefully to read it when they get their copy of the Journal in hand. The translation has been made at my request by Lieutenant Grenfell, of Her Majesty's ship "Excellent," who is the Honorary Secretary to that most useful institution, the "Junior Naval Professional Association," Portsmouth. As I was not sure that

* *Extract from the "Statesman's Year Book,"* 1873.—The French Navy is manned partly by conscription, partly by voluntary enlistment. There is an *Inscription Maritime*, on the lists of which are the names of all males of the maritime population, that is, men and youths devoted to a seafaring life from the 18th to the 50th year of age. The number of men thus inscribed fluctuates from 150,000 to 180,000. Though all are liable to serve, the Government, as a rule, dispenses with men over 40, under 20, as well as pilots, Captains, the fathers of large families, and able seamen who have signed for long voyages. The term of service in the Navy is the same as that in the Army, with similar conditions as to Reserve duties, furloughs, and leave of absence for lengthened periods. It is enacted by the law of 1872, that a certain number of young men liable to service in the active army may select instead the naval service if recognized fit for the duties, even if not enrolled in the *Inscription Maritime*.

For administrative purposes France is divided into five *divisions maritimes*, and subdivided into twelve *arrondissements*, as follows:—

Divisions.	*Arrondissements.*
1. Cherbourg.	Dunkerque, Le Havre.
2. Brest.	Brest, St. Seroav.
3. Lorient.	Lorient, Nantes.
4. Rochefort.	Rochefort, Bordeaux, Bayonne.
5. Toulon.	Marseilles, Toulon, Ajaccio.

At the head of the Administrative Government of each maritime division is a Vice-Admiral, bearing the title of "Préfet Maritime."

It is estimated that there are in the *Inscription Maritime* over 50,000 men!! between the ages of 25 and 50 who have performed *over six years' service in the Navy!!* and are available in case of war. The Royal Naval Reserve in England has been allowed to dwindle down to about 12,000 men, who are drilled for one month each year, but not more than 6,000 are supposed to be in England at the same time. The Royal Naval Coast Volunteers are almost extinct; the Coast Guard numbers about 4,000 men; so that on war breaking out we should have only a Reserve of 10,000 men immediately available, one-fifth of the numbers available in France. Ships in which to embark these men would of course be required, but the late American war taught us how a navy could be promptly improvised.

Lieutenant Grenfell's professional duties would allow him leisure to complete the translation, I requested Mr. Stock, the French Master of the "Worcester" training ship to make a translation also, which he was good enough to do. The translation I am about to read is that of Lieutenant Grenfell, whose acquaintance with the technical terms used leaves nothing to be desired.

Chapter XIII.

Classification of the Fleet—Creation of Special Corps.

Ships no longer grow old on their building slips; they leave them now-a-days to receive their engines as soon as the hull is finished. By this arrangement the loss by waste of material is considerably increased; and if a certain number of ships were not annually built, at the end of eighteen or twenty years the fleet would have entirely disappeared. Moreover, to assure its existence for this length of time, the greatest care must be taken in its preservation.

A budget which aims at preventing decrease in the *matériel* of a fleet must estimate not only for the cost of these new constructions, but must also, side by side with this fund, devote another special one to its preservation in good order. Two or three additional ships could be built every year were it not for the great cost of the maintenance and occasional complete refit, as well as of the mass of minor repairs, of those already constructed.

It is easy to imagine the embarrassment with which the Minister of Marine, at the close of the Crimean war, must have seen the arrival in port of all those vessels which, though he was obliged to disarm, he could not leave to perish entirely. Machinery does not the less need the services of an engineer, after it has temporarily ceased its active duties, for he alone can take charge of, clean, and preserve so much dormant national property. The traditional shipkeeper who sufficed for sailing ships would ill preserve the delicate machinery of a steamship; for while too long a repose would rust the different joints and bearings, there would be great risk of fracture or of destroying the true working of the various parts if they were set in motion by an unskilful hand.

The first care of Admiral Hamelin was to place these treasures under the superintendence of a staff which, though small, was sufficient to guarantee them from too rapid a decay. For the condition of complete disarmament he substituted an intermediate one to which he sought to give the name of "reserve." This fleet, which preserved the most important members of its crews, was a reserve in every sense of the term, for each ship had only to complete its complement of men and Officers, and to fill up with powder and provisions, to be at once ready to put to sea; but when the Minister came to estimate the cost which such a system of reserve would demand, he recoiled before its enormity. Complaints were also made by the northern ports that the maintenance of a too advanced state of preparation would expose the fleet to the danger of having to put to sea with machinery already

half-used, and which would be in a far worse condition than if it had been carefully protected in store. Under a southern sky, however, these difficulties did not exist, Toulon raising no objection to the condition of immediate readiness.

The decision finally taken by the Minister of Marine was to divide the reserve fleet into a sufficient number of classes to satisfy the wants of the moment and the various demands of the different seaports.

In the old Navy there were but two conditions: "In commission," and "Dismantled." For the new were introduced, "Preparing for commission;" "Harbour commission;"* "Fitted out for anchoring in the roadstead;"† "Half manned;" and lastly, "Fully commissioned."

"Half manned" answers to that state—unknown hitherto in the life of a ship—which now-a-days always precedes her entry into the ranks of the seagoing fleet, viz., when she is undergoing her various trials.

Adjusting the machinery of a ship requires from five to six months' work, during which time she may remain in a state of "preparing for commission," that is to say, having on board a staff which superintends but does not take any active part in the trials, and a crew whose only duty is to prepare her for leaving port; but as soon as all the machinery is fixed, the contractor impatiently demands repayment of his expenses; these demands it is impossible to satisfy until completely enlightened as to the value of the engines delivered; thus it is that, notwithstanding financial difficulties and the desire on the part of the Minister of Marine of diminishing the cost of commissioning the ship, she must nevertheless be more or less manned, and sent to test her engines at sea.

It will be sufficient to half-man her for these trials so long as she has her full complement of engineers and stokers. A Minister of Marine has thus three fleets constantly on his hands: one seagoing, another in reserve, and the third under trial; this last, owing to the uncertain result of experiments, to repairing and retouching, and consequently the frequent use of docks and basins, is incontestably the most likely to disarrange the estimates.

The fixing of a naval budget is very far from being an exact mathematical operation; a very large amount ought to be allotted to miscalculations. It is, however, very important that the figures should not be arranged at the expense of the construction of new ships, as there is always a temptation to do. Candour is not only the first duty of a Minister, but is also his wisest course, as it is impossible to mystify others in the budget without to some extent mystifying oneself.

The organisation of the *matériel* had been a work of at least five years. Admiral Hamelin solved this question in a manner which appeared to satisfy, and in fact did satisfy, every necessity. The preservation of the fleet in good working order was assured, and, not less important, harmonious working between the central administration and the seaports, was obtained. A single word sufficed to indicate the designs of the Minister, and to say all that was necessary with regard to the authorised expenditure and the prescribed pre-

* Commission de port. † Disponibilité de rade.

parations. It was a happy mixture of simplicity and economy to which nothing was wanting.

Nevertheless this was only a minor point, the really important question being the constitution of the *personnel* of the fleet.

Admitting that we possess the ship, no maritime nation can flatter itself in being able to man it so quickly as we can. The "Inscription Maritime" is a force which is always at hand, a reserve which itself preserves its ranks at full strength, while the very trade by which its members live, preserves them in full vigour and efficiency without need of training. It has its first and second classes of reserve, namely, the men of the first and second levies. One portion of this population, which lives by the coast fisheries, is always to be found on the coast; the other is employed on distant voyages. It is possible that this latter might be compromised by a very sudden declaration of war, if the fishermen were not at hand to supply the first armament, which ought to secure its return.

No resource has ever been more precious, and—if I may say so—none better managed. It is only too easy to rely too much upon it, and we have severely tested it at times; luckily this is not our only reserve, for we can apply to the same source as the Army for the third of our effective strength. Thus we have found that men have never been wanting whenever it has been necessary to rapidly pass from a peace to a war footing. A number of men do not, however, alone constitute a crew; if, as seems reasonable, we take for the basis upon which we should allot a complement to a ship, the *rôle* she will have to fulfil in action, it will be seen that it is indispensable to provide beforehand for certain special duties. A large extension was given to the system which was established by the Government of July of forming a school afloat for seamen-gunners; it was sought to have for each of these duties, men specially prepared by technical instruction, and furnished, like the seamen-gunners, with a certificate of efficiency. Thus to the port of Lorient was allotted the task of furnishing the fleet with men acquainted with the field exercises, while, in addition to training captains of guns, instruction for a certain number of youths in the use and application of signals, as well as of the helm and lead, was established at Toulon.

The creation of these two special corps was an admirable measure. To realise his idea, it had been sufficient for the Admiral to reproduce, with but some slight and insignificant changes, an institution already vigorous; but to assure the easy recruiting and constant supply of the various elements of the engineer staff was no easy matter. Though a text-book was authorized, six monthly courses established and thrown open to candidates of all grades, and appeal made to the industrial schools as well as to schools in the seaports, the scheme remained incomplete.

Frequently as a solution to this difficulty has been sought, the solution is still wanting. In truth, it is no less a question than that of creating a Navy within the Navy.

The *rôle* of engineer will not remain much longer a subordinate one; if the ranks of the other Officers of the ship do not speedily open to

them, the corps of Naval Engineers will forcibly create a position for themselves out of their own. No other solution will suffice.

I have reviewed in succession the different elements which compose a ship's company: the seamen gunners, the small-arm men, the helmsmen, and the engineers. I have only omitted those men charged with duties aloft, those sailors *par excellence* so honoured hitherto by the name of topmen. It was thought—very wrongly, I think—that we should be able to get them from the Merchant Navy sufficiently licked into shape, and that we could then complete their education during a cruize or two, as well as that of the *deck-hands*. The *deck-hand* is the main working unit of a ship's company; at times we see him on a yard furling a sail, again with a musket on his shoulder, or straining at an oar; while he is equally ready with a tackle-fall, hair broom, or a gun-handspike. The advance of mechanical appliances will eventually give him some time to himself; at present he has none, his *specialité* being to lend a hand to everything that is going on.

The decree of the 5th June, 1856, was one of those regulations which would have lasted a century in the days of Colbert or M. de Choiseul, for it guaranteed us good materials for our crews, leaving us only to find the cement to keep them together.

But here, perhaps, the desire of hastening and facilitating the manning of ships was carried a step too far. By sacrificing the cohesion of a crew, one great motive of emulation was lost. As provision for the rapid formation of a crew was alone made, on paying off it was allowed to disperse and scatter to the four winds of heaven.

This arrangement, which suddenly separates old comrades, old "chums," accustomed to undergo together the trials and privations of the Service, and equally proud and concerned in supporting the good name of their ship, is a most vicious one, to which a remedy must be found. We had, under the first Empire, regular 'man-of-war' crews —in other words, naval regiments, and during the last years of the Restoration, Permanent Divisions, but the Decree of 1857 allows of no other permanency than that of those officers and petty officers who are on the roster for sea service. All the others are subject to be discharged and completely dispersed.

Our naval barracks, no longer occupied by the Permanent Divisions, afforded a depôt for the special classes—a sort of reservoir, where the authorities sought for each ship commissioning the necessary number of gunners, riflemen, helmsmen, engineers, and deck-hands. Though I am unable to thoroughly approve of a system against which I have already made known my objections, it is impossible to deny that with these three institutions—the Reserve Fleet, Depôts for Special Corps, and the "*Inscription Maritime*," the Empire solved, in the most complete and economical manner, the problem of prompt mobilisation.

Though from 1858 to 1870 the Navy has many times been taken unexpectedly, at one time being asked to transport armies of 25,000 to 30,000 men across the high seas, at another, being required to have all its forces ready at a few days' notice, yet it has never been appealed to in vain. The rapidity with which those orders have been executed has excited the astonishment of foreign nations. Of all the great

powers of the State, the Navy is perhaps that one which has least deceived expectation. Though it is true that we have not had to undergo a naval war, at the same time we must never forget that, if France seeks to maintain her rank in the world, if her alliance is again one day to be sought for, it is always this crucial test of a maritime war which she must keep in view; and it is strictly with a view to obtaining the advantage in such a war that the constitution of her fleet must be arranged.

Chapter XIV.

The Uses of a Navy.—Considerations on Naval Matériel.

What is the use of a Navy?—is the first and most difficult question which a statesman in the present embarrassed state of the finances should ask himself.

My answer is given unhesitatingly—To occupy and maintain the great ocean highways.

The occupation of the seas, though it were only temporary, ought to have consequences of the very deepest importance, even in a purely continental war. It was thus that the Federal States of America triumphed over the resistance of the Southern States; it was thus that England eventually exhausted the resources of the first Empire; it was thus in the Crimea that we conquered Russia. The damage done to American commerce by a few privateers has been greatly exaggerated, and the capture of a French merchantman by a German corvette issuing in the depth of winter from an inaccessible and no longer blockaded port, has caused the most absurd sensation. A naval supremacy, however well established, can never entirely prevent depredations of this nature; at sea, as on shore, the convoys of a victorious force are never absolutely secure from attack. But what results can flow from these comparatively insignificant successes? Is it to be imagined that the bold deeds of twenty "Alabamas" could have delayed the fall of Richmond for a single day? If it is from a reliance on such facts that the paying off of our squadrons is demanded, and a mere predatory and privateering warfare prescribed, I, for my part, would ask the advocates for such a course to consider for a moment the following hypothetical case:—The French armies are again massed on the banks of the Rhine, while every sea is furrowed by the keels of our countless frigates and corvettes; but before our ports, cruises a German fleet, to which we have no fleet to oppose.

What would follow from such a state of things? All our coasts would be kept in constant alarm, all our ports would be asking for garrisons, and the whole of our maritime population would be exposed to falling into the enemy's hands. It has always been the cruel destiny of the crews of privateers to finish their adventurous career in the hulks, and by privateers I mean equally ships of war specially designed for cruising and those vessels which are equipped by private speculation. In the war of 1778, we saw our isolated cruisers succumb, one after another, the very day the high seas were momentarily abandoned to the English

squadrons. We ought in fact to look upon squadrons as so many moveable fortresses able to send forth their flying columns in comparative security to scour the surrounding districts. I am of opinion that before this predatory warfare could be set on foot, it would be necessary to sweep the seas. So long as the *broom* of Van Tromp remained at his main-mast head, the merchants of Amsterdam and Flushing were without fear; they knew well that their losses, should they experience any, would be light.

I do not deny that this predatory warfare may be the sole refuge of the weakest side. The moment the disproportion of the two forces has become too great, it may be well to disperse in order to reduce the chance of capture; but to accept this programme *à priori*, without knowing exactly which is the adversary fate is reserving for us, would be to foolishly abdicate our naval position in virtue of a force which is not yet in existence. What figure should we cut in the Mediterranean, for instance, if we gave up our squadrons in those waters? Shall we let it become an Italian or a Spanish lake, when we would not allow it to be a Russian one?

Unless fate gives us England for an adversary, we ought to be prepared to undertake *la grande guerre* at sea. Even against England herself, this line of action would be necessary on the very day that new complications modified the number and nature of our allies. It is from this basis, then, that I always consider any plea for the maintenance of our fleet.

Under the Empire, our war-fleet was a homogeneous fleet; each of the ships which composed it could turn in nearly the same circle. As long as ramming remains for our vessels the grand mode of attack, naval actions will inevitably be mere *mêlées*. It is, above all, necessary in *mêlées* to have ships which describe circles to all intents similar. At the same time I am far from thinking it impossible to reconcile the advantages to be derived from the progressive researches of science, with those which result from uniformity in construction. In a squadron, two or three ships working together form the tactical unit; in a large naval force, it is the squadron which becomes the unit, that is to say, a group composed of six ships at least, of twelve at most. Each squadron ought to manœuvre separately and independently, in such a manner as to achieve the result indicated by the orders of the Commander-in-Chief.

The homogeneity of the fleet can thus be given up, so long as that of each squadron be preserved. This programme will, no doubt, appear very limited to those who find fault with our naval architects for their timidity and lack of enterprise. Happily, we have other designs under trial than these costly constructions which form our first-class fighting ships. It is not now-a-days necessary to restrict in any particular those vessels which are not the equivalents of our old line-of-battle ships, save to some conditions of strength and speed; for they belong beforehand to no particular type, and each should be an individual design franked and guaranteed by its author. It is to this domain that I would direct the inventive boldness of our naval constructors.

Our progress in naval architecture has hitherto proceeded rather by

impulses than by any continued effort; from 1852 to 1857 the leap was enormous. All our youth was passed in fierce debates, in which theory and practice were ever at variance, when a young man appeared on the scene, who both loved our profession and had its true instinct. Him we took and raised above the rivalry, criticism, and barriers which opposed him on every side. His very first creation was a masterpiece. The productions of his original and fertile mind were called successively the "Napoléon," "Algesiras," "Gloire," "Solferino," "Océan." To him we owe the whole of that Navy of which we are so justly proud. This fleet is homogeneous, because it sprang fully armed like Minerva from a single brain. It is time that a new inspiration manifested itself; the same type is reproduced too often with modifications which indicate ingenuity of arrangement rather than fertility of design. We wait for a new "Algesiras," in other words, one of those ships whose appearance is at once a great event and a vast acquisition of strength. In the "Algesiras" it was not so much the ship herself which was the novelty, as her engines. In the merchant Navy less attention is paid than in ours to the external appearance of the machinery, and more to the results to be obtained from it. There is much to learn from those long voyages where extreme speed is maintained sometimes for weeks, and passages accomplished with a regularity which is rarely interrupted. When our ships of war are able to cross the Atlantic in company with any of our great mail steamers, they may easily dispense with the other trials which they now undergo. The science of the naval architect is, now-a-days, exceedingly complex; we are far removed from the days when builders handed down to each other the simple secrets of an hereditary art. In the architect, the engineer now-a-days rivals the ship-builder—I should say, surpasses him, for this faculty is by far the most rare and most necessary of the two. By study it is possible to become a builder, but one must be born an engineer.

The Administration—let it be well noted—is not generally so hostile to progress as is said or supposed; its extreme caution, which keeps it somewhat behind the times, is the result of that pitiless criticism which public opinion lavishes on all which is not on first trial an undoubted success. Could it obtain a little indulgence, the Administration would not view novelties with so much suspicion. What public opinion should do—if I may use the expression—is, give strength to the budget and wings to genius. We ought more than ever to aim at perfection in our constructions since we are certainly menaced with a reduction in the number of our ships. The question of pay is insignificant compared to that of the general expenditure of stores and the salaries of workmen. It is to the estimates for the *matériel* of the fleet that we must turn if we wish to economise seriously; but at the same time we must thoroughly realise what these economies are, which is not so easy as we might suppose. It is impossible on any given day to discharge the large population which lives on the work obtained in our building-slips. While we can economise in the matter of these expenses there are others in which it is impossible to cut down anything.

In fact, reductions should never be undertaken unless the principles on which they are to be regulated are thoroughly understood. I have

never had any doubt in my own mind about these principles; whenever it is a question of sacrificing either our dockyards or our fleet, the former, I affirm, must always give way. These grand monuments of our greatness must, I think, be sacrificed to preserve our ships; our national pride must submit to it. What matter if we display less magnificence to strangers, if we can confront an enemy with forces not sensibly diminished? This is the result to which we must aim.

I think I have already sufficiently indicated how, as far as the "*matériel*" of the fleet is concerned, we may still maintain our warlike condition; but in so doing I have only attacked the least important part of the question. The real point, as no one doubts, is that which concerns the living organism of the fleet; it is here, unquestionably, that a judicious and conservative scheme is required. I shall describe briefly one which I have conceived, at the same time I confess that I have sometimes exceeded my own programme. Although this is no time for too exalted views, I could not forbear from seeking to improve and perfect those institutions whose maintenance I have persistently demanded.

Chapter XV.

Constitution of the "Personnel" of a Fleet. The Officers and Men.

The real strength of any military organisation is measured by its effective force in officers and men.

This may, perhaps, be called a truism, though it is not the less important to be occasionally reminded of it. If I was not certain that the officers of the fleet will meet with respectful consideration, and that the hardly less valuable class of petty officers will be equally well treated, I should have but little hope in endeavouring to discover the future of the French Navy, for in a very short time our Navy would cease to exist; the zeal of Commissioners of Finance causes me but little anxiety on this point.

I wish I could speak with equal confidence of the proposals of our reformers; I fear certain schemes which appear to me stamped, I confess, with a peculiar imprudence. Among these I may mention one which aims at suppressing the training-ship which for nearly forty years has supplied us with all our officers. It is impossible, no doubt, that the Navy should completely escape from those reforms which will result from a considerable modification in our social system, but it would be curious if endeavour was made to pass it through most dangerous experiments just when its praises are in every mouth, and when it possesses a greater share than ever of public estimation.

I admit, perhaps, the necessity for a *free* training for officers, but I cannot understand how they can entirely do without training. It would be equally dangerous to apply serious modifications to our existing mode of recruiting our ships' companies. By the introduction of forced military service for all, the duration of which is to be divided into two or three distinct periods, every one in France will have to submit to the hitherto exceptional *régime* under which—not indeed

since Colbert, but since the latter years of the Government of July—the whole of our sea-faring population has lived.

If the "*Inscription Maritime*," such as the last decrees made it, continues to exist in some particulars as an exceptional *régime*, it will be due far more to the privileges it authorises than to the cost it imposes. I am unable to see what inconvenience would arise if that interesting class, which has such great claims on the State, continued to enjoy its privileges for some few years more. For many years it has been placed under the Admiralty, a guardianship it should not be deprived of too suddenly; the high degree of discipline to be found among French sailors is due to this constant though hardly visible attachment, a bond which could not be broken without the most serious disturbances being at once produced in our Service. A nomadic Navy, like that of the United States, would be the result. France would lose those devoted sons who exist along her coasts, those sailors, fashioned to obedience and discipline from their earliest days, who regard their native country with affection as the home of their declining years.

For these reasons I still look to the "*Inscription Maritime*" for producing the main portion of our crews, and to our training ships for giving that theoretical instruction to our young officers, which is essential for a sailor of the present day. Our profession, as I have already said, and not without some slight regret, was formerly an instinct, it is now a science. Let us work, then; let us work incessantly, since success is now-a-days the reward of labour alone. However limited our budget may be, I would still devote the greater portion of it to the instruction of our officers and men. The Navy has hitherto been most frequently employed on entirely imaginary duties; stationed to protect a commerce which often never existed, or on diplomatic service, where the chief difficulty lay in unravelling complications which it had itself produced. The only essentials of a peace armament are, in my opinion, those which conduce to the rapid formation of a war armament. Naval stations are not only useless, they are positively cruel. Three or four of the best years in a young man's life are devoted to an enforced absence in an unhealthy climate. A remedy for this has been proposed in constant circulation; it is the general wish of the Navy, to which I give my unqualified adherence. I make but one demand; that among all these ships constantly circumnavigating the globe, there should be one specially detailed for providing the fleet with properly certificated topmen. It is difficult to understand why, when all other classes have been deemed worthy of special training, the most important branch of all should have remained uncared for. The topman will always be the most intrepid and most intelligent man in the ship. The chief boatswain's mate* is incontestibly superior to all the other petty officers; it is to him, and not to the chief gunner's mate,† or chief-quartermaster,‡ that the regulations give the command in case all the officers are removed. The class of topmen is the nursery for these chief boatswain's mates. We see, then, that both justice and foresight counsel us to surround the recruiting of

* Mâitre de manœuvre. † Mâitre canonnier. ‡ Chef de timonerie.

this precious class with all those guarantees which assure the effectual discharge of duties in other branches of the Service.

The task of developing the child into the man has ever been considered a difficult one by philosophers. To make an officer out of a cadet does not demand less care. Supposing that one of these young scholars who leave the training ship sufficiently acquainted with the elements of their profession, was confided to my care, and that I was charged with training him for the rank of lieutenant in the most thorough manner, this is how I should set to work. He should make, first of all, two or three trips round the world. These voyages would "sailorize" him, without making him a thorough sailor. Should there be a certificate for seamanship, as there is for gunnery, musketry, and engineering, it should only be given to those who combine knowledge of pilotage with knowledge of handling a ship. It has always been my belief that the course of instruction will be incomplete until pilotage is taught as well as seamanship and gunnery. Training in this subject should be conducted where all the difficulties of navigation are united. From Bayonne to Dunkerque we find at once fogs, currents, and shoals; it is there our young officers and our quartermasters should be taken. The latter would there learn to watch the course of the vessel with more attention and intelligence; into whatever waters chance should take them, they would soon be most useful auxiliaries to pilots; while the former would soon have sufficient skill to do without pilots altogether.

Five or six years well laid out would give a young officer an amount of instruction of which he would feel the advantage all his lifetime. Before entering the higher ranks, he should be called upon to pass through the various schools which have been instituted for the different classes of which our crews are composed. He should become a rifleman at Lorient, a gunner at Toulon, an engineer at Brest and Indret. Having arrived at the rank of Lieutenant he would be ripe for the grand school of all, where all the acquirements and experiences of a young officer's education are put into practice; I mean the evolutionary squadron. This squadron, which was organised in 1825 by M. de Clermont-Tonnerre in the West Indies, and since that time has assembled nearly every year in the Mediterranean, is the source where all our officers and men from time to time renew their warlike spirit.

Even if this were its only advantage, the evolutionary squadron ought to be preserved at all hazards; but a consideration still more important, if it be possible, imperiously commands its maintenance. It is our only school of tactics.

The fleet which has the greatest acquaintance with tactical manœuvres will possess a great element of success in the day of battle.

When two fleets meet at sea, when the two lines, after hurling one against the other have been mutually penetrated, the action can only be continued by immediately reversing the course previously taken. This manœuvre, which will be almost inevitable, is of such a nature as to cause more than one involuntary collision between ships of the same fleet; the homogeneous composition of the fleet and similarity in their circles of turning will diminish these risks; skill in combined

movements will make them disappear altogether. It is not in the practice of *regular* evolutions and in the execution of geometric figures that proof is given of a trained and skilful eye. The practice which can alone develop the nerve required for most of the manœuvres which will be carried out on the day of actual combat is very different. Neither isolated cruises, nor the endeavouring to represent squadrons by a collection of despatch vessels and gunboats provide a sufficient school for this most difficult art. An Officer must learn how to handle in a very small space, masses of 6,000 to 7,000 tons, which cannot come into collision without mutual destruction; he must nerve himself to behold unmoved the imminency of the most terrible catastrophes; he must be accustomed to preserve a close-order both day and night; to know how to group, how to spread out, sometimes presenting a compact mass, at others, successive échelons; he must possess, above all things, the indispensable art of divining the intentions of his Commander-in-Chief, and by watching intently his slightest change of course, at once to comprehend and conform to his movements so as to be independent of his signals. *This is the whole secret of Naval tactics.*

There is but one definition for this word "tactics:" it is the art of sustaining the fight, and of not falling foul of each other. The most skilful are those who are able to combine their efforts even when the regular transmission of orders has become impossible. The very last economy France ought, in my opinion, to make, is that of giving up the evolutionary squadron. The day when the condition of our finances forbids us the maintenance of such a force, it will be necessary that at least every year an instruction-cruise — should its duration be only one month—be undertaken to prevent the total loss of those precious traditions which we owe to fifty years of toil. With a diminished armament, neither the period of service of the officers, nor the commands, can be of such long duration as hitherto.

If it be admitted, as I have endeavoured to show, that in time of peace but a very small display of force is necessary, and that the chief object of a naval armament is to instruct and train all those various elements which we shall need in the day of battle; then we shall naturally seek such an arrangement as will most widely extend instruction through the entire body of the Navy. This arrangement is to me self-evident; we must increase the number of cruises, and shorten their duration.

We have recently discovered among our blue-jackets aptitudes of which formerly we doubted; while admitting that they were good gunners no one believed that they would ever make more than indifferent soldiers. Though one of those who hold that we should never lose sight of our own proper profession, and though I should regret to see seamen neglect their proper and traditional sphere of action to become an auxiliary branch of the Army, I have not the less constantly protested against the views of those who would discourage our ever disembarking our men. I am very glad that events have shown what these landing-parties can be; the action of our fleets on an enemy's coast will become far more efficacious. Would it not be very

lamentable if the 5,000 or 6,000 picked men on board a squadron were not always ready, without further assistance, to execute a *reconnaissance*, a *coup de main*, or a descent on an enemy's coast? Every considerable assemblage of ships should be able to forthwith furnish troops sufficient to undertake any of the minor operations of warfare. I have long since discussed this question with young officers who will one day have to realize it, and I have never ceased to demand that the number of small-arms allowed to each ship should be considerably increased, companies for landing provided with those materials for encamping without which it would be impossible to leave the sea-coast, and that a section, provided with the necessary tools for throwing up an earthwork or clearing away an obstacle, should always accompany our riflemen and mountain artillery. That which the Roman fleets and the Norman invasions were able to accomplish, our squadrons, when once they had swept the seas, should be in a position to attempt. When every ironclad shall carry on her sides seven or eight steamboats, which I think is indispensable, no squadron will appear on an enemy's coast without spreading alarm and causing a vast amount of destruction.

It would be superfluous to insist upon this view of the matter; a complete transformation in our social system will be due to the misfortunes we have just gone through. Every Frenchman is about to become a soldier. Those hopes, which I formed less than a year ago without concealing from myself the great difficulties which might defer their realization, will be accomplished if the Navy is only allowed to follow the natural tendency of events in the present day.

Many people will be astonished to see me develop with such calm confidence a programme which breathes so little discouragement; more than once my friends have rallied me upon what they are pleased to term my "robust hopes." We shall see whether the future will prove them or me to be right.

Struck by a mortal blow Charles XII carried, it is said, his hand to the hilt of his sword. Shall we, for a wound less deep than many we have often inflicted on other nations, resign all hope, and despair of the future of France? What may become of the organisation of the Army during the critical phase through which we are passing, I cannot say; but I think I can confidently state what that of our Navy ought to be in the present day.

Chapter XVI.

The Fleet of the Future.—Institutions which are absolutely essential.

To gain our point, it is by no means indifferent from what conditions we start; the very best reasoning will only lead to a false conclusion unless the premises are sound.

What is the principle on which the organisation of our fleet should be based? On that principle which was true in all time and which is an hundred times more true to-day—neither Colonies nor Dockyards make a Navy, but *Ships*. The Colonies must seek elsewhere than in our budget the means for squaring their expenses; the

Dockyard must lose the opinion of its own greatness, and be content to become the very humble slave of the Ship. "We all, while we are "here," said Admiral Lalande in 1837, then Superintendent at Brest, "are but the servants of the servants of God. Our resources, we only "accumulate to dispense to those who will have to make use of them; "a seaport must never be judged by its workshops or stores, but by "the ships it fits out." This is wise language, containing in its brevity a complete system. In order that those passions that are so natural to the heart of man should not prevent its accomplishment, I could wish that history never related a naval action without saying—"the ships which have fought were built by such a Naval Architect, equipped by such a Maritime Préfet, and commanded by such an Admiral."

As for the Minister, all success ought to redound to his glory; when an operation is successful, it is unquestionably he who should be first rewarded. The victor is but his emissary and his debtor. Why does public opinion hasten to consider him as a rival? Mean competition which, though it does not breed a refusal of active support, still embitters the mind and alarms patriotism! He who is occupied with the work of organisation is frequently tempted to envy the luck of those nations who have everything to create, and have not to clear away those obstacles with which time has obstructed our path. It needs but so little money to procure a fleet, and so very much may be spent on a Navy of long standing, without in the end being certain of possessing one! For the sum which two years of our old estimates would have given us, the fleet which the Empire left us could be built. This fleet, it is true, would last barely twenty years. It would be necessary thus in twenty years to have put by the value of another such fleet. This sinking fund, which is gradually expended on the annual constructions, instead of being accumulated in the coffers of the State, constitutes the main part of that which is called the normal expenditure. It is impossible to make any retrenchment in this sum, unless we consent to a rapid decay of our naval power; but, in my opinion, saving would be effected without loss of strength if we confined ourselves to merely preserving in good working order the whole of our transport fleet, instead of renewing it. If we are seeking for economies, this is one which will cost us but little in point of actual strength.

I believe I can indicate another, whose importance will readily be recognized. The annual sum for new constructions depends on the rapidity with which materials decay. The amount of this sum will be considerably reduced, if, in future constructions, wood is replaced by iron. It is true that this substitution will necessitate the purchase of new apparatus, that our stores of oak will be no longer of service, and that the mass of our carpenters will have to be discharged. The scheme is thus not so simple as it appears at first sight. It is a reform to be made, but one to be made with extreme caution. As for the workshops, basins, and all that fleet of stone, which, made for producing and preserving the fleet of wood and iron, for the most part devours it, its further development must be arrested, and we must content ourselves with allowing it a sum sufficient to maintain it in its present condition. On an annual credit of 65 millions, economies in

matériel ought to furnish us the means of saving those institutions whose defence I have undertaken.

The separation of the Admiralty and the Colonial Office* will also assist us. I should not propose to create, as in 1857, another portfolio; the Chamber of Commerce will undertake the administration of interests which are rather commercial than maritime. As for the Colonial garrisons they properly belong to the War Department. This little Army, which has always been increasing, has everything to gain by being absorbed into the great national Army. The services it has rendered, and the bravery it has shewn, ought to procure it this honour. While a mere pendant to the Navy it would still have continued to vegetate as an auxiliary corps. A far wider field must be opened to it, and the occasion seized, which we let slip fifteen years ago, of simplifying the arrangement of our Naval budget. We must still have Officers to build, to command, and to man our ships; doctors to tend, and chaplains to instruct and minister to our crews, and there must be no reduction made in these essential branches, whether civil or military, of our Service. The pay which they get is but a drop in the ocean of the Naval Estimates. For the cost of one ironclad frigate, we could afford to double, almost to triple the number of our Officers. M. Hyde de Neuville, who perhaps more than any Minister understood and defended the great interests confided to him, gave utterance during the Restoration to a saying, which is worthy of deep consideration, "We must economize in *things*, never in *men*." If it were possible to impose silence for a moment on the jealousies of the human heart, and to go with an unprejudiced mind to the root of the matter, it would be seen that never was a truth so incontestable. It is possible to ruin many a life, to totally destroy the organisation of a great Service, without realizing by such ill-considered retrenchment, the decrease in expenditure which would be represented by the coal which it is sometimes so easy to save.

I most earnestly demand that no reduction be made in the number of the ships which we ought to be able to place in line of battle. But what purpose would the fleet serve if the *personnel*, without which our men-of-war are but useless toys, is to be disorganised? "The fleet," I shall be told, "will not be reduced, only the number of ships kept in commission in peace-time. Many of your Officers will find themselves without employment. It is not only their zeal which will suffer from such enforced inactivity, but still more so, their professional knowledge. A Naval Officer is not formed in barracks, nor in harbour, but at sea." A remedy for this state of things is easily found, and was applied during the first years of the Restoration; England and the United States have had recourse to it: An Officer must be permitted to serve on board merchant ships—on board private ships, is what the regulation of Louis XVIII says—without any loss of position. To me it only seems fair that he should not lose those claims to promotion which his seniority would give him. If we here apply the principle of renewing leave of absence, a reserve

* Now combined under one administration.—Trans.

of Officers will be assured almost without expense, as the "*Inscription Maritime*" has assured one of seamen. In the last thirty years I have seen several of those ideas which I ardently propagated, both patronised by public opinion, and adopted by the Admiralty. During these thirty years my opinions have been modified, though never falsified, by the course of events and the revolutions achieved by science. I find them in 1872 but little altered from what they were in 1842 and in 1859.* No doubt there are some on which, if needs must, I could accept some modification; but on those which appear to me fundamental, neither the misfortunes of the present day nor the mania for change, could gain from me the slightest alteration. I pronounced in a previous chapter the words "*Institutions Necessaires.*" These institutions I enumerate again. The first is incontestably the "*Inscription Maritime;*" the second, our system of separate schools for special subjects, to which must be added a school for topmen, and one for pilotage; the third is called the evolutionary squadron. Save these institutions and you will save the Navy.

If our Naval power was not situated on two seas very far apart, I should prefer having our central administration placed in one of our sea-ports rather than at Paris. I have long held this opinion. The river of time which hurries everything onward in its course does not spare the best thinking powers of a sailor. After having drunk for some years of these waters of Lethe, the sense of the deep needs of our Navy becomes less keen; other matters occupy our minds and engross our attention; little by little we sink under the moral stupor which invades us. The deserted fleet drifts hither and thither at the will of the waves, and we run the risk of only finding it again when it is among the breakers. Since a Minister of Marine can neither live at Brest nor Toulon, he should at least go frequently to both places; this, while reviving his zeal, will excite that of his subordinates. He should be seen everywhere, coming unexpectedly without pomp or excitement, in our dockyards where his presence would instil fresh life, at the trials of new ships, and on board our training ships in the midst of officers and men. These inspections could not be made too frequently; the work would be better carried on, and progress would be more real. There are few questions which would not be better solved if they were studied on the spot, whether by the Minister in person, or by the members of the Admiralty Board,† or by those of the Constructor's department.‡

How many contradictory orders and unfinished undertakings should we not be spared! As for business, the very worst way of carrying it on is by telegraph. With its oracular obscurity this mysterious wire is the most hateful instrument that an Administration ever used. By it, honest work has given way to undue haste, well-digested orders and explanations to feverish dialogues. It is impossible for one man to see and do everything himself; it is by far the wisest plan to repose

* See the author's "De l'Organisation Militaire de la Marine." (Extracts from "Guerres Maritimes" and "Souvenirs d'un Amiral)."

† Conseil d'Amirauté.—Trans.

‡ Conseil des Travaux.—Trans.

complete trust in those who see and those who perform. For a Minister, as for a Commander-in-Chief, or a King, the secret of governing is to know how to decide.

Hitherto I have been occupied with conservative schemes alone; it must, however, be thoroughly understood that if we make too sudden a halt we shall soon find ourselves left behind. Stagnation in these days is the very worst imprudence. Everything is advancing, ships, guns, engines, everything—even powder.

The practice-grounds, the great factories belonging to the State or subventioned by it, are also necessary institutions; nevertheless, much cost might be spared if we knew how to profit by those studies which other nations undertake. It is absurd to endeavour to experimentally determine every point for ourselves, and to seek from purely speculative researches what is after all only a trade-secret.

The Russian Navy sets us a very good example on this point. Russian officers are seen everywhere, and prove themselves to be, as a rule, very judicious observers. Very little of interest occurs in the naval world without their becoming immediately acquainted with it. The battle of Lissa was hardly fought, than one of their Admirals hastened to Ancona to examine the ships and question the officers and men who had taken part in it. We travel too little; we are neither acquainted with foreign ports nor foreign dockyards, while ours are constantly being visited by intelligent travellers. A special fund ought to provide for those doubly fruitful missions.

I repeat it; what our Navy has done in the last fifty years is nothing to what it will have to do in the event of a naval war. I have very often sketched in my mind the constitution of a fleet which could at any given moment unite its scattered fragments, and concentrate formidable masses on two or three previously chosen points. I asked myself how our institutions, our budget, and the distribution of our forces could be made to contribute to carrying out this idea. I revived on a larger scale the plan of 1805, convinced that the fleet which can most promptly concentrate, ought to be able to keep for several months the advantage gained in the first few days; for the return of its scattered seamen would be assured and those of the enemy intercepted; but it is impossible to undertake such operations if the fleet be not accompanied by a complete train of store and provision ships. We have constructed transports for troops and horses; these might be got rid of without great inconvenience; what we want are transports for provisions, and, above all, for coals. These latter will be of a type quite novel and very difficult to construct. Mixed transports of inferior speed will be nearly useless. The transport we need must be as swift as the squadrons whose operations they must accompany.

If I am not mistaken this is, indeed, a vast scheme; let us defer, if you will, its realisation, but let us not for that entirely lose sight of it. The day will come when a more fortunate generation will, perhaps, deem it too modest. The eclipse which we are undergoing, will be more or less long; but France is destined to emerge from the shadow, and our descendants will have difficulty in comprehending our present discouragement.

In the midst of the bitterness with which our hearts are overflowing, I fix my eyes on a future, which we of an older generation shall not see, but you, for whom Heaven in its mysterious dispensations is preparing it, take care that it does not come upon you unawares. Do not imitate the foolish virgins of Holy Writ, whose lamps were without oil when the bridegroom came. Watch! for who can tell the moment when it will be said, "The hour is come"? Watch! and most carefully preserve our great institutions. The Navy of To-morrow will then have no cause to envy the Navy of To-day.

Captain GOODENOUGH: I think you will feel no inclination at this late hour to commence any discussion on this paper. I merely ask you to return your thanks to Admiral Ryder for his kindness in taking so much pains in bringing it before us; we know he never spares any pains for our good. I would merely say that Admiral Jurien is known not only as a consummate writer on naval affairs, but as an elegant French writer—that he is known as such even amongst academicians. I therefore think that younger members of our profession cannot do better than read his works as a study of French, as well as a study of the particular subject of which they treat.

LECTURE.

Friday, February 28th, 1873.

LIEUT.-GENERAL SIR FREDERICK CHAPMAN, K.C.B., Director-General of Fortifications, in the Chair.

MANTEUFFEL'S CAMPAIGN IN THE EAST OF FRANCE.

By Captain H. A. GUN, R.E.

The section of the Franco-Prussian War of 1870-71, about which I have put together these notes, is that which had for its scene the country about the Côte d'Or and Jura Mountains in the south-east of France, and is known indifferently as the operations of the Army of the East, to French, and of the Army of the South, to German, writers. The central operation round which the campaign hangs, is the Siege of Belfort. It was to relieve that fortress, that Bourbaki led his army from Bourges to Montbeliard, and fought a three-days' battle there; and it was in the first instance to protect the besieging army, that General Manteuffel carried the IId and VIIth German Army Corps across the Côte d'Or and Plateau of Langres. It was in this campaign that Garibaldi took a part,—a part unfortunately hardly worthy of the hero of Italian independence. Finally, this campaign was the last act of the Great War, lasting after the curtain had fallen over the rest of France.

In order to avoid overcrowding of names on the map, some of the places alluded to in the text have not been placed on it. Their situations can be easily identified by referring to the following table:—

Baigneux les Juifs, Chanceaux, } between Montbard and Lamargelle.
Marac, N.W. of Langres.
Bligny, Verey, } near St. Seine.
Echenans, north of Hericourt.
Byans, Champey, Busserei, } villages in front of Hericourt, on right bank of the Lisaine.

St. Marie, Aibre, Tavey, } villages in front of Hericourt, on right bank of the Lisaine.
Bethoncourt, between Hericourt and Montbeliard.
Mignavilliers, Faymont, } near Athesans.
Arcey, near Montbeliard.
Thil Chatel, close to Is-sur-Tille.
Dain, Plombières, } villages about Talant.
Fontaine, close to Talant.
Abeny, Messigny, Darois, Ruffey, } villages north of Dijon, on the road to Langres.
Ornans, south of Montbeliard.
St. Fergueux, four miles east of Villersexel.
Etuz, on the Soane, near Pin.
Rioz, near Montbozon.
Censeau, north of Nozeroy.
Forests of Chailloz and Chatillon, on the right bank of the Doubs, above Besançon.
Verne, near Rioz.
La Barre, close to Dampierre, on the Doubs.
Deservilliers, south of Amancey.
St. Laurent, south of Les Planches.
Chaffois, Sombacourt, } road Levier-Pontarlier.
Varois, Mont Seine, Rolland, Bourg } between Dijon and Auxonne.
Sancey, west of Hyppolite.
Frasne, near Pontarlier.

It is not easy to assign an exact date for the commencement of a set of operations; and the 18th of December, 1870, has been chosen in this lecture, because it is a convenient time at which to consider the relative positions of parties, not because it was absolutely the commencement of the campaign.

The country in which the operations took place lies in the Departments of Côte d'Or, Jura, Doubs, and Haut-Rhin, in the old provinces of Burgundy and Franche Comté.

The principal natural features are the Côte d'Or Mountains, the Plateau of Langres a continuation of the same group on the west, and the Jura Mountains on the east. These ranges, especially the Jura, are of considerable height and importance; they are much covered with woods, and except by the roads which traverse them, are impassable for troops. The columns marching on these roads can have little communication with each other, as there are few cross-roads, and such

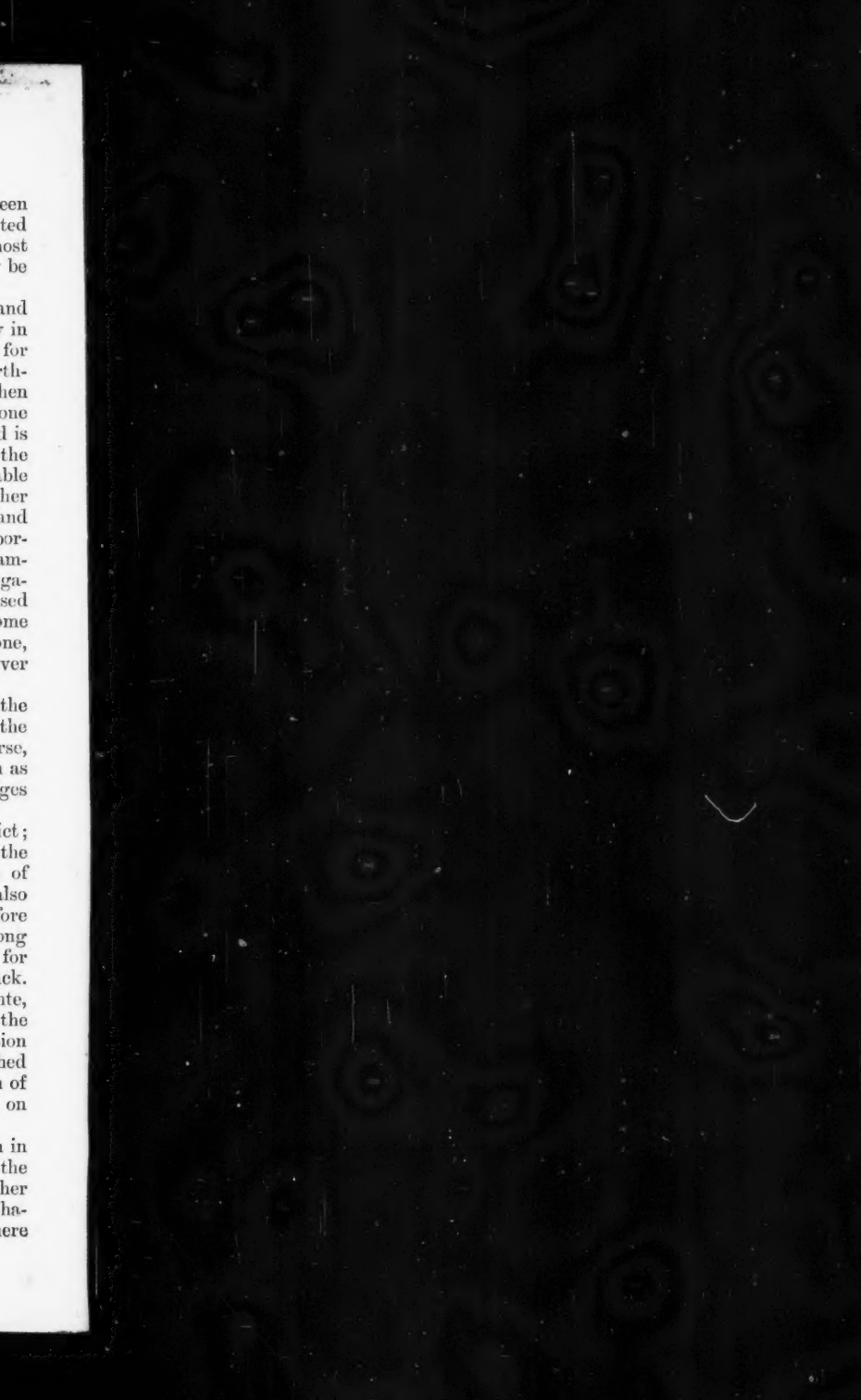
as there are, are indeed only poor ruts or paths. The country between the ranges, though never flat, is comparatively so, and is well cultivated and rich, with numerous towns, villages, and free passage in most directions. Here also are numerous woods, however, and it may be termed a close country for military movements.

The large river Saone receives all the water of the district, and traverses it from north-east to south-west. It varies considerably in width and depth; but, in general, a full pontoon train is needed for passing it. Its principal tributary is the Doubs, which flows first north-east, forming the boundary between France and Switzerland, then turning round the north of the Jura, flows south-west to join the Saone at Verdun. It is a swift, deep stream, 40 to 100 yards wide, and is therefore a considerable obstacle. The Doubs at its head receives the Lisaine, a small stream running between steep hills, affording admirable defensive positions; the Savoureuse, which flows by Belfort, and other waters. The Burgundy Canal comes from the north-west to Dijon, and thence to St. Jean de Losne, where it joins the Saone. It is of importance as a means of transport along the south of the theatre of the campaign, but there are many locks on its course, which retard the navigation. The River Ognon is a considerable stream, which cannot be passed by troops. It joins the Saone at Pontarlier. The Tille, also of some magnitude, flows along the foot of the Cote d'Or to join the Saone, south of Auxonne. The Suzon joins the Ouche at Dijon, and this river then flows to the Saone parallel to the Burgundy Canal.

Finally, on the western side of the Cote d'Or, rise several rivers, the Amançon, which the Burgundy Canal follows to the north-west, the Aube, Seine, and Marne, all here small streams. There are, of course, numerous small waters feeding the above-mentioned rivers, but such as could be crossed by a trestle-bridge equipment in the absence of bridges or pontoons.

There are four fortresses, three of the first-class, in the district; these are, Belfort, situated in the well-known gap between the Vosges and Jura Mountains,—a gap, however, full of hills, some of considerable size. Belfort has a powerful enciente, and has also detached works, some of long standing, others constructed just before and during the war. Besançon, in a loop of the Doubs, a very strong place, with detached works, rather too close to the fortress for modern warfare, but nevertheless sheltering it against an attack. This town could protect 10,000 or 15,000 men within its enciente, and a large army in its immediate neighbourhood. Langres, on the northern spur of the plateau, had received a great deal of attention from the French engineers before the war, and with its four detached works, could only be taken by regular siege. Auxonne, the fourth of the fortresses, is a small bastioned work of no great importance, but on the Dijon-Dole railway, at an important point.

Dijon, not now a fortified town, is of importance from its position in the Cote d'Or, from its size, 30,000 inhabitants, and from its being the railway junction from Paris to Lyons and Switzerland. The other towns that may be noted are, Dole on the Doubs, with 9,000 inhabitants; Gray on the Saone; and Vesoul with 7,000. At these there



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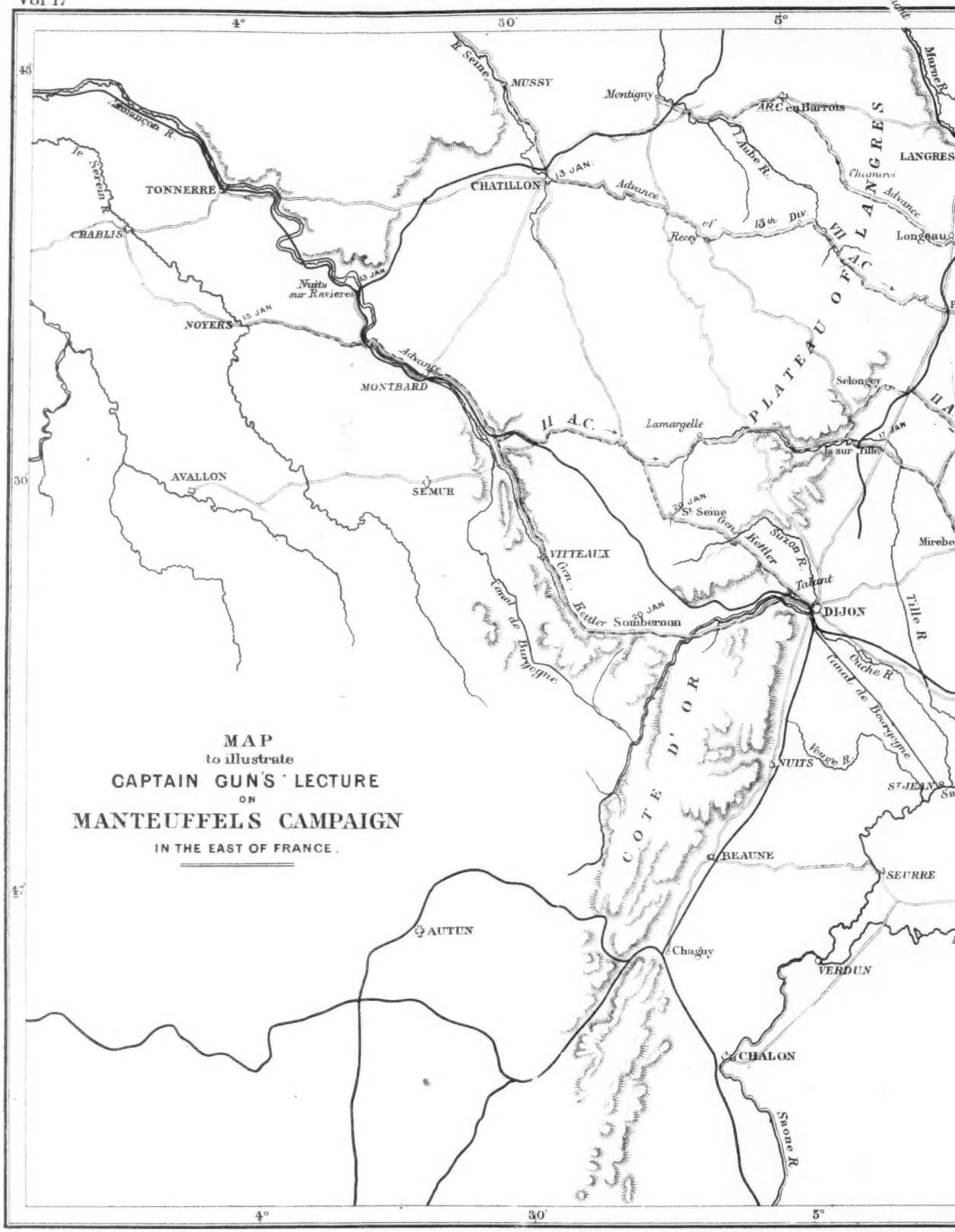
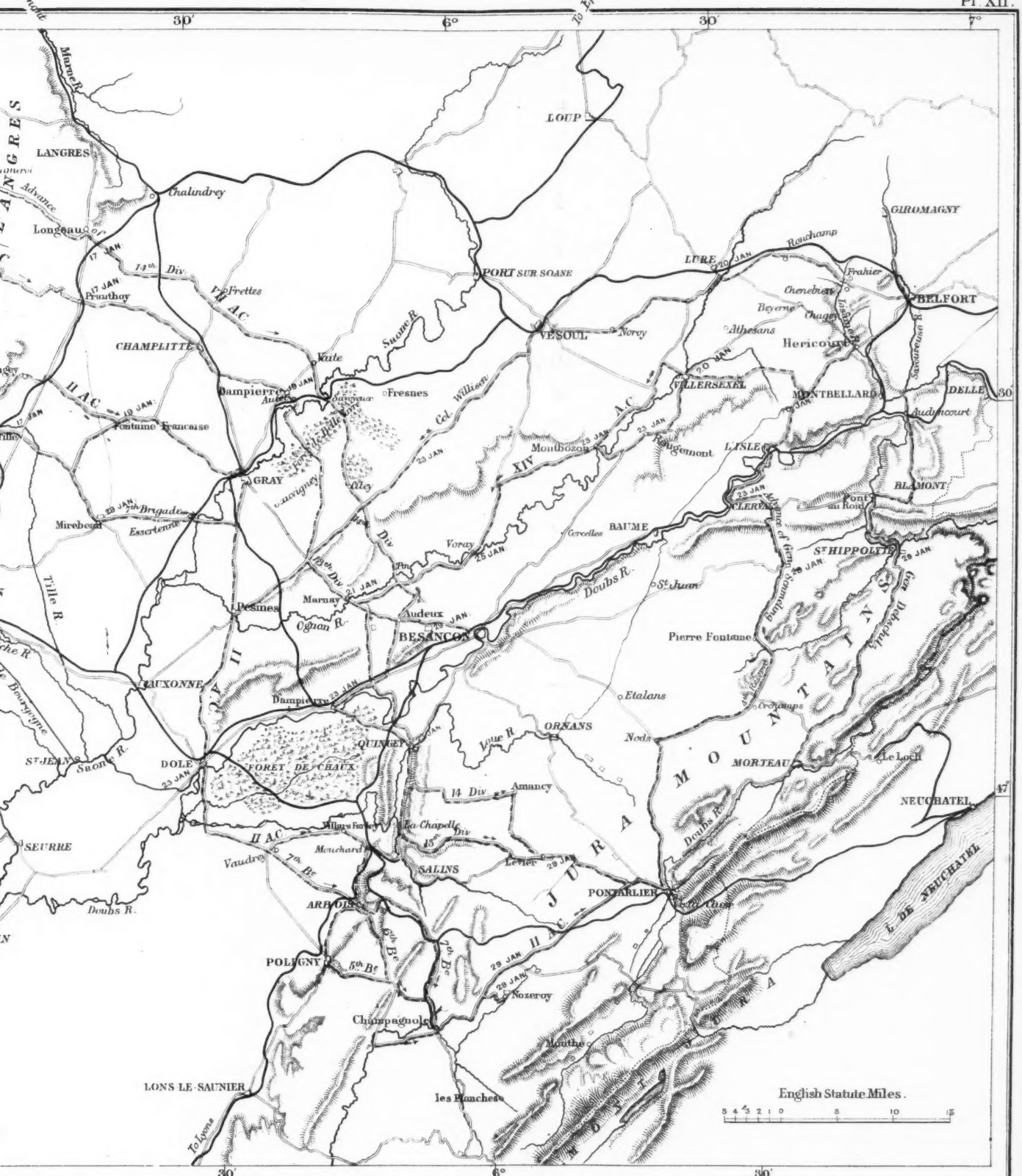


MAP
to illustrate
CAPTAIN GUN'S LECTURE
ON
MANTEUFFELS CAMPAIGN
IN THE EAST OF FRANCE.


To Chaumont
To Epinal
30'
6°
30'
7°
LANGRES
Marne R.
LOUP
Chalindrey
Longeau
GIROMAGNY
Ronchamp
LURE
PORT SUR SOANE
Frahier
Chenebier
BELFORT
Beverne
Chagey
Athesans
Hericourt
VESOUL
Noroy
Saone R.
CHAMPLITTE
Vaite
Dampierre
Fresnes
Col. Williese
VILLERSEXEL
MONTBELLARD
DELLE
Audincourt
Fontaine Française
Montbozon
Feigennot
L'ISLE
BLAMONT
GRAY
Mirebeau
Essertenne
Pont au Roid
BAUME
Cercelles
Voray
Doubs R.
St Hippolyte
St Juan
Pesmes
Marnay
Ognon R.
Audeux
BESANCON
Pierre Fontaine
Tille R.
Dampierre
Etalans
ORNANS
Nods
Loue R.
QUINGEY
DOLE
FORET DE CHAUX
Amancy
MORTEAU
Le Locle
NEUCHATEL
Villers Farlay
La Chapelle
Mouchard
SALINS
Levier
PONTARLIER
SEURRE
Vaudrey
ARBOIS
Doubs R.
POLIGNY
Nozeroy
Champagnole
Mouthe
LONS LE SAUNIER
les Planches
To Lyons
English Statute Miles.
5 4 3 2 1 0 5 10 15
II AC
I AC
XIV
7th Div
14th Div
18th Div
7th Bde
6th Bde
5th Bde
17 JAN
19 JAN
20 JAN
21 JAN
23 JAN
25 JAN
29 JAN

J. Jobbins

are also railway junctions. Chaumont, Chatillon, and Tonnerre are towns on the north-western side of the district, and Montbeliard and Pontarlier lie in the Jura, the latter town being nearly on the Swiss frontier. The railways are, the great Paris-Basle line, on the north, passing by and closed by the positions of Langres and Belfort; the Paris-Neufchatel railroad passing by Tonnerre, Dijon, Auxonne, Pontarlier; the railway to Lyons from Dijon, diverging to Bourges at Chagny, a place to be noted on that account: and the cross lines of Nuits-Chatillon-Chaumont, Auxonne-Vesoul, Gray-Langres, Dole-Belfort. These last are all single lines.

The line from Vesoul north by Epinul leads to Nancy and Metz, and is very important in a military sense, as was illustrated in these operations.

There are numerous good roads connecting all the towns; the national and departmental roads are all of the first-class, the communal roads, some good and some bad, but in great part admitting the passage of artillery. I will only allude especially to one of these roads, that right through the Jura by Salins and Pontarlier and La Cluse on the extreme frontier, and for the reason that at Salins and La Cluse are hill forts, which, if occupied by artillery, completely close the passage, and this circumstance had considerable effect at the end of the operations.

Before indicating the positions of the armies on the 18th December, I will, in a very few words, sketch the operations preceding which led to them. After the fall of Strasbourg, on the 27th September, 1870, General von Werder, with the XIVth Army Corps and detachments, in all 55,000 strong, with 150 guns, was detached to the four Departments I have named above. His orders were to lay siege to the places near the Rhine, and to Belfort, and generally to oppose the formation of new corps of the enemy, and to crush "insurrections," as they were rather unreasonably termed, amongst the inhabitants. The siege of Belfort was commenced by the 1st Reserve Division, General Treskow, 17,000 men, on the 4th November, whilst von Werder pushed on and occupied Dijon, Gray, Vesoul, &c. Besançon, Auxonne, and Langres remained in the possession of the French; at a later date, General von Goltz, of Werder's Army, began the siege of the latter, but was repelled before he had received heavy guns, or made any impression. General Debschitz, also of this Corps, was occupied with the fortresses on the Rhine until the end of December.

On the 4th December, the final rout of D'Aurelle de Paladin's army took place at Orleans, and the French Government immediately proposed a new set of plans for the further prosecution of the war. These consisted in the formation of an army under Chanzy, whose mission was to draw on himself the forces of Prince Frederick Charles, whilst a new army, to be called "of the East," was assigned to General Bourbaki, and was to co-operate with Garibaldi, who, with 10,000 men, which were being rapidly added to, was at Autun, south of Dijon; conjointly they were to raise the siege of Belfort, push von Werder northwards, and so come down on, and cut the communications with, Strasbourg and Metz, or carry the war into Germany,—a bold and

ambitious scheme certainly, but one which necessitated great promptitude and much organization.

Accordingly, the XVth, XVIIIth, and XXth French Corps were withdrawn from General Chanzy, and a new corps—the XXIVth—was formed at Lyons, and assigned to General de Bressoles, who had risen rapidly in rank during the war. Under him General Cremer had a division: he was a young and energetic, but rough and somewhat boisterous, Officer, who had escaped from captivity in Germany under circumstances which the Germans at the time considered equivalent to a breach of patrol. General Bourbaki had commanded the Imperial Guard at the commencement of the war, and had a considerable reputation, but apparently, as an Imperialist, he was under some suspicion, and a M. de Serres was attached to him as a sort of public safety man, or commissioner, an arrangement which probably hampered the General a good deal.

About the 18th December the arrangements for this Army of the East were completed, and the concentration of the troops—120,000 strong, with 300 guns—had taken place. General Cremer had already moved to Autun. These operations were closely watched by the Versailles authorities, and the VIIth German A. Corps, less one division, was moved from the country about Troyes, where it had lain on the communications with the east to Chatillon, to be in observation. Prince Frederick Charles also had a division at Vierzon, near Bourges, and abstained for the present from following Chanzy to the west.

We have then on the date mentioned,—in Belfort, 17,000 men of mixed, regular troops, and mobiles, under an energetic commandant, Colonel Denfert Rochereau, an Engineer Officer, resisting General Treskow's attack with about the same number; in Langres, a French garrison of 10,000 or 15,000 badly-organised mobiles, under Colonel Mazière, an Engineer Officer also, watched by General von Goltz, with 6,000 men; in Besançon, 15,000 men; in Auxonne, a small garrison of mobiles; at Autun, Garibaldi, with 13,000 men, badly trained, and so indifferently equipped, that a few days later he could not move his troops because they wanted great coats. It will be recollected that it was mid-winter, and exceptionally cold. At Nuits, south of Dijon, Cremer, with 15,000 or 20,000, being the advance of the army of Bourbaki; that General, with 100,000 or so, was at Bourges, assembling the XXth Corps; the XVth Corps was about Vierzon, watching Prince Frederick Charles. The XXIVth Corps, less Cremer's division, was at Lyons.

On the German side, the Baden Division of the XIVth Corps, General von Glümer's, was in Dijon; the 4th Reserve Division, General Schmeling, was principally in Gray and Vesoul; and, as we have seen, General von Goltz, with a special detachment, observed Langres, and General Treskow, with the 1st Reserve Division, and some small detachments, besieged Belfort, where the second parallel against the forts on the Paris road was just being constructed; General Debschitz, with 6,000 or 7,000, was in East Elsass.

The VIIth corps, General von Zastrow, had one division on the scene of action about Montbard, Chatillon, and Chaumont.

We learn that another plan of action to that decided upon, viz., the relief of Belfort by the whole Army, had been proposed to the French Government at Bordeaux, of whom M. Gambetta was the ruling spirit, and M. de Freycinet the acting War Minister. This plan would have directed Bourbaki's army by Nevers, La Charité, and Montargis, on to Fontainbleau, whilst Garibaldi, assisted by the newly formed XXIVth corps, pressed on Werder and relieved Belfort. This was abandoned, as it would have involved again meeting Prince Frederick Charles to the east of Orleans, and no success could have been hoped for against his army. The plan already alluded to was then decided upon in greater detail. Bourbaki was to march on Dijon with XVIIIth and XXth corps, de Bressoles on Besançon, there to rally to him the garrison. It was calculated that at Dijon there would then be 70,000 (with Garibaldi) against 40,000 Germans; that the latter would be overwhelmed, and that a joint advance on Belfort would be made from Dijon and from Besançon. The case which actually occurred of von Werder not waiting to be thus beaten in detail did not apparently present itself. The XVth corps was to remain at Vierzon for the present.

The object of the French Army was the relief of the siege of Belfort and their chief starting point, Bourges, distant 220 miles. At Lyons were great stores, and one of the army corps, and the first base of the French may be said to be the line Bourges-Lyons; the railroads from these two points in the direction of Belfort, pass between the Côte d'Or and Jura Mountains, and Dijon and Mouchard, places at the feet of these ranges respectively, are connected by rail. These may be considered, therefore, as the extremes of the second base of the French Army. On this base, was a small fortress, Auxonne, in their possession, and somewhat in front another, Besançon, of the first rank. The western end, however Dijon, was at the begining of operations in the enemy's hands, and its possession was of the first importance. From this base, the movement up the valleys of the Saone and Doubs must be made, and it was therefore essential that it should be kept in French hands in order that supplies might be received during an advance, or that the means of retreat by rail should be secured.

As a safeguard during either of these operations, the lines of the Saone and Côte d'Or must be held against an enemy advancing from the west.

The base of the German Army entering the theatre from the west, would be the line Chaumont—Nuits connected with each other by rail, and each communicating with Paris. The second natural base in an advance on the Saone, is the line Langres—Dijon connected by the road running at the eastern fort of the Cote d'Or range. The extremes of this base were in the actual circumstances held by the French, and, therefore, a third more advanced base became necessary on the Saone itself between Gray and Vesnel, unless Langres and Dijon were first occupied by the Germans. This base on the Saone could not be supplied by the lines of railway from Chaumont and Nuits, since these pass by Langres and Dijon, but by its own prolongation to the north to Epinal, a town in German hands; that place omes, therefore, the

real base of the Army when arrived on the line of the Saone, or if from this line it should swing round on Besançon and Dole.

On the 18th December fighting began. General von Glümr in command at Dijon, had moved out on the 16th with his two brigades of infantry, a division of cavalry and artillery in two columns, and on the 18th attacked Cremer at Nuits on the Dijon-Beaune-road. Ricciotti Garibaldi came from Autun with a brigade to assist General Cremer. The French were beaten and retreated to Chagny, but the Badeners returned next day to Dijon without holding so advanced a position. It does not appear why Garibaldi remained at Autun (23 miles distant, but connected by rail) during this period. There was indeed then and afterwards a deplorable want of unison between him and the other commanders.

On the 23rd, General de Bressoles came to Nuits and assumed command of Cremer's troops. I may here state that owing to disagreements between de Bressoles and Cremer, the latter was henceforth given separate command of his division of about 15,000 men, and worked independently in future.

On the 25th, the XVIIIth corps arrived at Chagny from Bourges. On the 27th the Baden Division was withdrawn by von Werder from Dijon, and retired on Gray; General Cremer with Garibaldi's chief of the staff entered Dijon the same day, de Bressoles returned to Besançon and began to operate with the XXIVth corps in the Jura towards Montbeliard. General Garibaldi remains at Autun; he was very ill at the time, and, probably on this account, unable to display his old energy. On the German side it was still uncertain whether these movements were intended for an effort against Chaumont and Troges by Langres, or against Belfort; the VIIth corps, therefore, retains its position of observation about Chaumont.

General von Debschitz arrives at Delle near Belfort, from East Elsass, having reduced the Rhine fortresses.

On the 31st, the XVth French corps leaves Vierzon, Prince Frederick Charles having decided to follow Chanzy to the west. Bourbaki's army was therefore now complete.

On the 2nd January, 1871, Colonel Bordonne, chief of General Garibaldi's staff, receives particulars about the VIIth German Army Corps; it is estimated by his informants to be 16,000 or 17,000 strong; he also hears of the march of large numbers of Germans from Montargis, by Sens, Jugny, Tonnere, and from Villeneuve and Troyes, to a point of concentration between Chatillon and Chaumont. These were in fact the IInd Army Corps troops now ordered down from the siege of Paris, and the other division, the 14th, of the VIIth German Corps. It is hardly necessary to state that the divisions of the German Army are numbered consecutively, two belonging to each corps, so that the 3rd and 4th divisions belonged to the IInd Army Corps; the 13th and 14th to the VIIth Army Corps. The XIVth Army Corps was, however, made up of divisions not so numbered. This day, too, the 2nd, De Bressoles got to some outpost fighting with Treskow's troops at places near Delle, and their presence was duly reported to Versailles; still, however, the staff there did not feel sure about the objects of the new army, of the concentration of which they had good information.

It is possible that a bold movement of Ricciotti Garibaldi undertaken at this time, tended to keep them in doubt. That brigade commander was detached from Dijon with 2,400 men about the 2nd; he threw some outposts out of Senur to the west, and on the 8th had an engagement with detachments of the VIIth Army Corps near Montbard. He was defeated, losing half his force, but made good his retreat to Is-sur-Tille, fighting his way through Baigneux les Juifs, and established himself between Dijon and Langres on one of the Côte d'Or passes on the 14th inst. This, however, is in anticipation.

On the 1st the bulk of the French were in the towns on the railway between Auxonne and Clerval; the XVIIIth corps principally about the former place; the XXth corps about Dampierre; the XVth at Clerval: this last corps had been sent on from Basançon by General Bourbaki, and appear to have suffered great hardships from the want of preparation for disembarking or feeding them at Clerval. General Cremer remains at Dijon for the present.

General Bourbaki had his head-quarters in Besançon. Two courses of action were there discussed by the French Staff. The first of these would have sent two corps, the XXth and XXIVth, from Besançon up the Doubs, marching on either side of that river to Clerval; thence by the great road to Blamont, and crossing the Doubs at Audincourt, they were to debouch east of Montbeliard. The XVIIIth corps would proceed from Auxonne or Besançon by Rougemont on Villersexel, and then to Chagey (8 miles west of Belfort). The XVth corps would have formed the general reserve, and would march from Clerval to the west of Montbeliard. The Cremer Division would move on Langres, take up the garrison there, and form a mobile corps to protect the passes of the Côte d'Or and the left of Bourbaki's army in conjunction with Garibaldi at Dijon. It was argued that the position of the Germans in front of Belfort would then be taken in front and in reverse, whilst the Doubs and the Bergundy canal would with the railway serve to victual the army. In case of reverse the same good roads as they advanced by would be open for retreat as well as also those, equally good, traversing the length of the Jura range. It will be seen, however, I think, that, as the case stood, Von Werder, with his 40,000 troops, would have overwhelmed the XVIIIth corps, and Cremer's at Villersexel, and then have moved to the east against the XVth, XXth, XXIVth, whilst, if Treskow could not have held his own against these latter in front of Belfort, he would have easily joined Werder who would have been then united on the French left.

The second plan simply consisted in massing on Villersexel and Vesoul, where Werder was expected to be found, and fighting him there (should he wait).

Cremer alone was to move as soon as possible round by Gray on to the German flank.

No provision was to be made to guard the Coté d'Or passes beyond what Garibaldi could do, and moreover it was left an open matter between Bourbaki and Garibaldi, which should be responsible for the passages of the Saone and Doubs.

On the 2nd January the XVIIIth Corps moved from Auxonne, and crossed the Ognon at Pesmes; the bridge there had been blown up by the Germans in retreating, and the infantry crossed on the ice, the artillery and cavalry on a bridge of boats.

The XXth Corps moved up to Voray from Dampierre, sur Doubs, and crossed the Ognon there, and both marched on Villersexel.

The XXIVth Corps assembled in Besançon; its outposts had been all over the Jura; it followed the other corps to Villersexel.

The XVth Corps also moved in the same direction from Clerval and Beaume les Dames.

Cremer remained at Dijon for the present, the line of rail not being clear for his movement to Vesoul.

On the 5th, Girabaldi moves from Autun, reaching Dijon on the 7th, and henceforth we are to consider him posted there, and held responsible for the protection of that important place by the War Administration at Bordeaux. He had no cavalry or field artillery worth mentioning, but many guns to mount for the defence of the town, and this he did, strengthening it especially on the side of the Montbard road, where the ground favoured him.

9th January. General von Werder had determined on a retreat to a battle position, the length of the Lisaine, and had some of his troops there at this time; he determined, however, to check the heads of the French columns before taking up his defensive attitude; he had already had reconnaissances made of them as they advanced, and there had been some outpost fighting. This morning he advanced early from Vesoul with the 4th Reserve Division (Schmeling) and von Goltz's detachment, which had been withdrawn from Langres, probably 10,000 or 12,000 men, and appeared before the Chateau of Villersexel, a magnificent pile, the property of the Marquis de Grammont, just before the French advance came up to it. All that day a serious fight took place about the chateau, which with the town remained in the German hands at night-fall; next morning these left it before daybreak, and fell back on the Héricourt position, where active preparations were made for a stubborn defence. The siege of Belfort was continued unintermittingly, but siege guns were withdrawn to put on the heights overlooking the Lisaine.

The 10th. General Bourbaki rested to obtain provisions; the 11th, 12th, 13th, he distributed his troops between Villersexel, l'Isle-sur-Doubs, and Lure; and only on the 15th was ready to move from those places for the attack of von Werder on his chosen position. Cremer moved on the 9th from Dijon, and on the 19th reached Lure. The Germans in retreating had not destroyed railway or bridges; they expected assistance from the west, and left the passages open. On the other hand, and for the same reason, Cremer ordered the destruction of bridges behind him, but these instructions were entrusted to civil engineers and local persons, who dreaded German reprisals on them, if they as civilians took part in the war, and the orders were neglected. Bourbaki was 120,000 strong, but his troops were deficient in provisions and clothes.

We have particular accounts of the wretched plight of Cremer's

corps on entering Lure on the 14th. General Cremer indeed ordered double rations of everything, including brandy for men and *horses;* it is pathetically added by an eye-witness that the intention was good, but, as there was nothing to be had, could not be carried out. Here we must leave them for the present, only noting the length of time it had taken to bring the Army from Bourges, whence it started on the 20th December to Hericourt, where it arrived on the 14th Jannary. The story of the delays, as told by M. de Freycinet and others, is a sad tale of want of organisation and direction over the lines of railway, as well as of miscalculation of their powers of transport on single lines.

By the 11th January the reports from Von Werder relative to the fight at Villersexel on the 9th, where portions of all four French corps were engaged, had fully established the object and extent of the French advance, and, as at the same time all difficulties in the west were over by the successful battles at Le Mans on the 10th, the Versailles Staff determined on the formation of an army to be called "of the South," to be placed under the orders of General Manteuffel, who had handed over the command in the north to General von Göeben.

That day, the 11th, General Manteuffel had an interview with the Emperor William, and quitted Versailles next morning for Chatillon, there to commence his operations.

There was much in favour of an advance on Dijon; the railways to Montbard were in German hands; Garibaldi could be easily overwhelmed; and the railroads when repaired, would afford a secure base for operating between the Saone and the Doubs, whilst the connection of the French with Bourges would be severed.

Time would, however, be lost in making this circuit from Chatillon to Belfort, and it appeared to General Manteuffel that it was incumbent on him to take the shortest route, so as to press at once on the forces attacking von Werder. This would be by the roads to Vesoul. Should General von Werder have to retreat, Manteuffel could follow the French and redeem the situation; should he hold his ground, Bourbaki would be placed between the two armies; in the case of his being victorious and of the French retreating (as happened), then, by swinging round to the right from Gray, the Army of the South would cut off the enemy from Lyons, and force them to fight in the Jura, capitulate, or cross the frontier. In order, however, to move on Vesoul with his full force, it would be necessary for the German Commander to leave Langres and Dijon behind him, slightly watched, and to submit to the loss of his communications with Chatillon, the roads from which run between those places. Therefore he prepared a new base at Epinal; thither was sent the train of the 14th Division, which had not yet joined it, from the north, where the VIIth corps had been engaged, and there was established, under the direction of the Governor-General of Loraine and the Etappen Commanders, the provisions and stores which would be required on reaching Vesoul or Gray.

On the forenoon of the 13th, all these decisions were arrived at at the headquarters at Chatillon, and the position of General Manteuffel's corps on that date was as follows:—

IInd Army Corps at Nuits sur Ravières and Noyers nearly complete

about 27,000 strong, with 84 field guns and but few cavalry. General Fransecky commanded the corps.

VIIth Army Corps had one division about Mussy and Chatillon and one at Montigny; this latter, the 14th, without its train and wanting several battalions; the corps was less than 20,000 strong; General Von Zastrow in command.

General Kettler, with a brigade of infantry, two battalions, and two squadrons, was to "contain" Garibaldi, and was left about Montbard. The 1st Reserve Regiment of Hussars, previously left at the disposal of the Etappen Inspector-General at Nuits, was also available for General Kettler.

The French had parties of troops between Langres and Dijon: at Langres, 10,000 or 15,000 Mobiles; at Dijon, as we have seen, Garibaldi's force was 15,000 strong.

General Von Werder was in telegraphic communication with Versailles, as also was Manteuffel, and so they communicated with each other; but the wire from Paris only extended to Chatillon, and the messages were for the next fortnight sent on to Manteuffel's headquarters by post relays, which worked in an admirable way, notwithstanding the bad weather and the scouting parties of French about. Neither IInd or IIIrd Army Corps had a field telegraph equipment.

General Manteuffel, as we have seen, aimed at Vesoul; he had to traverse the Côte d'Or mountains and debouch on the great Dijon-Langres road in the first place, and he formed three columns for that purpose. He foresaw that these columns, in traversing the wooded mountains, would see little or nothing of each other, and in the "instructions" issued from Chatillon, the Commanders were directed to march through as quickly as possible to their respective points of sortie, viz., Is sur Tille, Prauthoy, Longeau. Arrived there, they could extend parties along the great road and feel and wait for each other. The "instructions" concluded with a noteworthy sentence: "I hereby ratify in advance all measures for which my sanction is necessary, so that the hands of the commanding Generals may not be tied by any regulations."

14th. The IInd Army Corps marched in the direction of Montbard, Chanceaux, Selongey.

The VIIth Army Corps right column: Chatillon, Recey, Prauthoy; and left column Montigny, Arc en Barois, Chameroy. The day was intensely cold, the roads very good but were covered with ice, and it was only by the greatest exertions that the guns could be got along. The advanced guards marched well ahead, and encountered Ricotti Garibaldi's force, which was dispersed.

16th. A division of the 7th Corps reached Longeau, and sent outposts towards Langres; these were shelled from the forts.

17th. The remaining division of the VIIth Corps, after four days' march, reached Longeau, and sent advanced guards on to Champlitte, Fontaine Francaise, and Mirebeau, turning a few troops out of these places. Railway and telegraph at Chalindrey were cut by them. I should mention that a skirmish had taken place at Marac on the left of the VIIth Corps' march during the passage of the mountains, where

troops from Langres had been posted. This excepted, the garrison had made no opposition to the movement.

IInd Army Corps had a division, the 3rd, this morning at Is sur Tille, from whence Menotti Garibaldi with a brigade retired without fighting, though they slightly molested the outposts on the right.

The 4th division of this corps was still in the mountains echeloned back to Lamargelle. It had been delayed by combats at Bligny and Verey, with 3,000 Garibaldians from Dijon.

Whilst the IInd and VIIth Corps were thus successfully threading the passes of the Côte d'Or, General Von Werder was engaged in a three days' battle before Belfort, and this, the turning event of the campaign and a conspicuous scene of the war, must now be described.

The excellence of the positions on the banks of the Lisaine has been already noticed.

The line taken up was extensive for 35,000 men, about the number Von Werder had to dispose of without calling on Von Treskow's besieging division for assistance. On the right, about Chenebier, stood the Baden Division, Von Glüner; the right centre was held by General von Goltz, who stood at Echenans in force, and occupied Byans and Champey in front. The centre and left centre was watched by the 4th Reserve Division, General Schueling, who had troops in Hericourt, Bussurei, Bethoncourt, and Montbeliard, the outpost in the villages of Ste. Marie, Aibre, and Tavey. These outposts were driven in by the advance of the French. Montbeliard is a point of the greatest importance. It is alike on a junction of railways and roads leading through the gap of Belfort. Its occupation by the enemy would turn the whole line and throw the army off its line of retreat into Elsass. It was therefore fortified with care. The castle rises above the town, which forms a very strong post, and here and on the hills around were planted many guns. Thirty-seven of the siege guns, including 16 24-pounders, were in position here and at different parts of the line, 12 at the castle 25 at adjacent points.

The extreme left was held by General Debschitz. Finally, a grand reserve was formed between Hericourt and Brevilliers, at which latter place were General von Werder's headquarters..

The French arrangements for the attack of this line were thus made: On the 15th, XXth and XXIVth Corps were to march from Arcey to Hericourt, spread out there, and attack whatever was before them. They marched on the high road between L'Isle and Hericourt. XVth Corps to march from L'Isle to Montbeliard, and attack that town. One regiment, the 24th, was detached to the right of the town to turn the position, and there of course met General Debschitz' force. The XVIIIth corps was ordered to march from Villersexel on Chagey by Athesans, Miguavilliers, Faymont, Beyerne; finally, the Cremer division was to march on the departmental road from Lure to Hericourt, as far as Beyerne, there to turn off to the left and attack the enemy's right about Chenebier. These last two movements were most unfortunately directed. From Villersexel to Chagey there are no good roads, and the XVIIIth Corps struggled all day along the "sentiers" which were covered with ice and snow. Cremer's division had a good

march to Beyerne, but thereabouts were cut in two by the XVIIIth corps marching at right angles to them, and then having to quit the main road and take to the abominable "sentiers," did not get to any work before Chenebier until 3 P.M. Part of their route, which had been specially indicated by a Staff Officer of Bourbaki's, lay across a frozen pond, and a spectator congratulates himself that the German batteries did not fire a few round shot which would have left them floundering in the ice. It seems difficult to explain why the XVIIIth Corps did not march from Lure to Hericourt, and the corps of Cremer from Lure by Rouchamp to Frahier, where both would have good roads and avoided collision. We see throughout, the want of a good staff, and of organization on the part of General Bourbaki; the roads appeared to be quite unknown to him.

On the 15th, the French pushed on with much vigour about Hericourt and Montbeliard, occupied all the villages on the right of the Lisaine, and the town of Montbeliard itself, but failed to take the castle or to cross the stream, on the left of which the strong position of the Germans lay.

The night was fearfully cold; the French troops, half-clothed and less than half-fed, lay huddled round bivouac fires, without distinction of ranks. It may be mentioned, as an instance of their want of provisions, that a horse struck by a shell during the day's fight was forthwith cut up into steaks, and cooked on the spot.

16th.—Cremer's division now fully up on the right, carried Chenebier, and penetrated to Frahier, the troops of von Goltz then falling back to Chalonvillars. No impression was, however, made on the rest of the line.

17th.—Generals Degenfeld and Keller marched before daybreak, and after some fighting, retook Chenebier, and forced back the French left. The fighting on the rest of the line was continued, but with less spirit by the French, who were not in trim for such a long-continued combat.

In the evening, therefore, General Bourbaki found that he could hope for no success against such strong and well-held positions, and ordered a general retreat.

The nature of the country precluded the use of the German cavalry, of which we hear nothing during this battle. It was despatched either during the action, or immediately after, round by the Lure road to open communications with Manteuffel's advance.

The losses were considerable, but not excessive, on both sides. The Germans lost about 1,700 killed and wounded, the French about double that number. The numbers engaged have been already stated, viz., about 120,000 French and 35,000 Germans.

It is curious to turn to the garrison of Belfort, and see what impression was made upon them by the battle so long continued a few miles only outside their forts. They appear to have had little or no information of the strength or position of the approaching army; they heard the cannon at Villersexel (21 miles) on the 9th, and then on the 15th along the Frahier-Montbeliard line. They also were aware, by the slackening of the siege fire, that guns had been withdrawn from the

batteries, and the Commandant eagerly hoped for the opportunity which might rise if the investing army was weakened. He made eight reconnaissances of a few hundred men or so, on the 15th, 16th, 17th, five towards the north with the view of proving the strength of the enemy; one of these had fighting on the Paris road, but all were driven back by the German outposts, which were not weakened. No sortie on a large scale was made. At this period of the siege, the Germans were strongly entrenched in their lines round Belfort, and the distance at which these were now drawn round fortresses with detached forts is to be noted as a difficulty in making effective sorties.

General Manteuffel was at Prauthoy whilst his columns were marching through the Cote d'Or, and it was there that he received each day by telegraph and post from Chatillon the account of the previous day's fighting round Belfort; on the 17th, we have seen his columns in great part disengaged from the mountains, but he was not then certain whether Bourbaki would be beaten off; he therefore decided to press on towards Vesoul especially with the VIIth, his left corps, bearing in mind that should the march to the right, already thought of in case of Bourbaki's retreat, take place, this flank of the army would have to march farther than the other to perform the outer sweep of the circle.

18th.—The VIIth corps marches from Prauthoy and Longeau to Champlitte and Frettes, still in two columns.

The IInd corps from Thilchatel towards Fontaine Française, a short distance only, waiting for its tail yet in the mountains. An advanced guard was sent on to Gray to destroy the railway which was the means of communication of the French with Dijon, and to made good the bridges over the Saone. News now came to Prauthoy of the Belfort victory, and retreat of the Eastern army, and Manteuffel at once decided on his preconceived flank march; the essence of which would be the rapid seizure of the railways from Besançon to Dole and Mouchard. When this idea was communicated to General von Moltke at Versailles, he is said to have observed to the Emperor that it was a manœuvre of great boldness, and that blame should not attach to the Commander of the Southern Army in case of failure, as such important enterprises involved corresponding risks.

19th.—Detachments pushed by VIIth corps towards Vesoul and to Lure secure those places, and look out for Willisen, known to be detained by von Werder with 1,200 cavalry in that direction. The bulk of the corps reaches Dampierre on the Soane, and Vaite.

The IInd Army Corps collects about Fontaine Française, a brigade, the 7th, well to the right, to watch Garibaldi, who, however, makes no sign.

Von Werder, having rested on the 18th, follows, this day, Bourbaki, who was in retreat towards Besançon.

It seems surprising that Garibaldi and Mazière at Dijon and Langres did so little in these days to harass their enemy. We have heard of Menotti and Riciotti Garibaldi with small parties in the Cote d'Or, but of the masses, nothing. General Bordonne (he became General about this time), Garibaldi's Chief of the Staff, declares that they were left

without any information, either from Bourbaki or Bourdeaux, and that being without cavalry he could make no reconnaisances. He believed, moreover, that the whole of the IInd corps remained at Montbard ready to move down on him if he quitted Dijon. We have, however, seen that General Kettler with a small force was really there alone.

General Manteuffel rightly judged that by this time, however, the 19th, the real state of things would be known at Dijon unless some means were taken to further deceive the Staff there, and mask the German advance. Accordingly he ordered, and it was faithfully executed, one of the most conspicuous and boldest enterprises of this war. It was entrusted to General Kettler.

We have seen him left at Montbard on the 13th. His force was 5½ battalions infantry, 2 squadrons, and about 2 batteries artillery. On the 10th he had been to Avallon, to punish that town for firing on a patrol, and had returned to Montbard the 17th. He was now ordered to move on Dijon, and attack that place with his little force. I propose to follow his movements during the next three days in the execution of this successful little feat of war.

Dijon is now an open town, the ancient ramparts being laid out as gardens. It lies at the foot of the Cote d'Or, which close in round it on the north and west, and partially on the east; the south is an open country, studded with vineyards. The Bourgoyne Canal, Avallon Road, and Paris Railway enter by a valley on the west, and the road to St. Seine and Montbard to the north of these. This latter passes in a defile between two hills, Talant and Fontaine les Dijon, very suitable for defence. Further out from the town is another defile at St. Suzon.

Garibaldi had artillery at Talant and Fontaine, and had fortified these posts. His total strength in guns was 60, viz., 20 12-pounders, 40 of smaller size, and as well as 20 mountain pieces. He had, I believe, 30,000 men in about the town.

On the 20th Kettler reached Sombernon, on the southern, and St. Seine, on the northern road from Montbard to Dijon, in two columns.

The 21st, his left column, forced the St. Suzon pass after some opposition, and reached Daix at 1.30 P.M. He then attacked the troops there, not in great number, and occupied them until the arrival of his right column (which had crossed the railway and river) at Plombières.

The whole force then advanced and drove the enemy back to the Talant and Fontaine hills, upon which no impression was made; after a loss of 14 officers and 320 men, Kettler withdrew to Abeny. Here he was joined by Major Couta, with the Fusilier battalion of the 61st regiment (Pomeranian), who had been left at Is sur Tille by the 2nd corps to keep up communications and escort a train. Major Couta had to attack a strong force of enemy at Messigny (said to be 6,000 strong) on his way to join Kettler; he drove these back, however.

22nd. Leaving his patrols in observation, Kettler withdrew to Darois out of sight of the French, who were in a great state of excitement in the town, believing that the whole of a German corps was on them.

23rd. He attacked again on both sides of the Langres road,

marching by Ruffey, and penetrated almost to the town; but the artillery fire was too strong for his progress, and at dark, after losing many men, he retired up the Langres road.

It was in this day's action that, as is well known, the battalion of the 61st lost the only colour taken during the whole of the war by the French, who found it next morning under the bodies of the standard-bearer and lieutenant. The Emperor William, I may add, ordered a new set of colours to be presented to the battalion, in August of the same year, with every mark of honour.

After this sanguinary fight General Kettler remained in observation about the town, changing his detachments very often, and keeping the enemy in check; and so successful had been his operations that the Garibaldians asserted that 70,000 Germans had attacked them, coming from west, north, east, and probably believe so to this day.

We may now turn back to the main advance of General Manteuffel's corps, and watch the measures taken to intercept the French Army retreating from Montbeliard. The ultimate fate of that Army is well known, and appears, indeed, inevitable, seeing that they had failed before the single corps of von Werder, and two fresh corps were now arriving, but it is interesting to trace the steps which led to the final consummation.

19th. General Manteuffel's chief desire now was to learn if the French were making entirely for Besançon, or in part for Vesoul and Langres. It turned out that a certain number had taken the latter route, but von Werder's reports seemed to give assurance that it was only the case in a small degree, and that he (Werder) would move round to Rougemont, so as to prevent any further movement.

20th. VIIth corps crosses the Saone at Savigneux and Autet, and moves on to the line Savigny-Citey, the advanced Guards towards Besançon. Patrols to the left in Vesoul.

IInd army corps about Gray, the heads of the columns ten miles in advance, and advanced Guards on to Pesmes; the bridge over the Ognon there had been destroyed by the XIVth corps, and had to be repaired. In the meantime a pontoon bridge was thrown. (It will be remembered that the 18th French corps crossed here on the 1st January.) The 7th brigade, which had been left about Mirebeau to observe Garibaldi, finding everything quiet (it was the day before Kettler's attack), marched on to Essertene and crossed the Saone there; a battalion was left at Mirebeau and remained there during the rest of the operations. The XIVth corps moves into Onans, St. Fergeux, and Athesans.

The trains of the IInd and VIIth corps were this day brought to the right bank of the Saone, and it will be seen that General Manteuffel had now fairly severed himself from his communications with Chatillon. Owing to the inactivity of the Langres garrison (we have seen what means were adopted for keeping back the Dijon people) posts did pass between Chatillon and the head-quarters of the Army without intermission, but the service of provisions would necessarily be stopped. Manteuffel was now on his new line of communication with Epinal, but it was not yet open to him, the enemy being in Vesoul and elsewhere

along the line. It will be remembered that the 14th division was yet without its train, which was still detained at Epinal. Colonel Willisen, who had two regiments of cavalry and a battery of horse artillery, and who would clear the country from Loup to Vesoul, was therefore anxiously expected on the left. The Southern Army was indeed, as we have seen, weak in cavalry. This day Willisen reached Lure.

The 21st. Colonel Willisin reaches Noroy-le-Bourg to the right of the XIVth corps; VIIth corps is at Marnay, Pin, Etuz, on the Ognon. These three places were held by troops from Besançon, who before retreating partially blew the bridges, and detained the heads of the German columns in consequence. Patrols moving to the left, heard of Cremer's corps about Rioz and Montbozon, just in the line of von Werder's advance.

2nd Army Corps reaches Pesmes. Its advanced guard seizes Dôle (14 miles ahead), and there surprises some troops of the enemy, and storms the town; the bridge had not been destroyed by the French. No less than 230 cars of provisions moving up from Bourges by Dijon were captured, a most important circumstance in the then state of the two armies—both in want of stores.

Von Werder is in Villersexel and neighbourhood.

Colonel Willisen at Noroi-le-Bourg, near Vesoul.

The retreat of the French was now fully directed on Besançon, from whence they could reach Lyons, their only point of safety.

22nd was a day of comparative rest. The VIIth corps reached Dampierre on Doubs, stationing part of a division on the Marnay-Besançon road, to cover the movement to Dampierre from the garrison at Besançon. The bridges over the Doubs found uninjured, which saved time, as the pontoon train of the corps was at Epinal, and only that of the IInd corps available to cross the river here, 300 feet wide. The IInd corps also crossed at Dampierre, and pushed on to save the passages of the Clone, Loue, and Orain, small tributaries of the Doubs. These were uninjured and undefended, though obstacles were found constructed. The main body marched to Dôle.

Bulk of the French about Besançon, but de Bressoles corps still near Blamont in the north of the Jura, watched there by General Debschitz.

23rd. By the evening the corps were thus situated. Werder at Montbozon, Rougemont, L'Ile-sur-Doubs, Clerval, having turned the enemy out of these places. VIIth corps astride of the Doubs at Dampierre and Quingey, facing Besançon; its outposts near that town were attacked in the evening by some of Bourbaki's troops, whom they thus for the first time encountered.

2nd corps remains in Dôle, where General Manteuffel has his head-quarters. Advanced guards on to Vaudray; a brigade under Colonel Knesebech covers the communications back to Gray.

Willisen is in Vesoul, which he cleared of troops, and thus obtained the line of railway. It had, however, been broken, and was not yet available for transport.

We are arrived at an interesting moment of the campaign. General Manteuffel was at the foot of the Jura. He held the Besançon-Dijon

and Besançon-Lyons railway, and it now behoved him to consider his prospects of enclosing thoroughly the enemy before him. We have fortunately one of those valuable but rare aids to military history, the views of the responsible commander at the moment of a crisis, not written as so many have been, after the event. I allude to Manteuffel's General Instructions, written on the evening of the 23rd at Dôle, and sent out to Corps Commanders early next morning.

He considers that there were at that time six courses that were possible for the French Commander to pursue:—

(1.) That he might essay the road leading southwards by Ornans, Levier, Censeau. Then the IInd and VIIth corps, who have troops well across the Doubs, must throw themselves in his way.

(2.) He may attempt to force through by Dampierre and Quingey. He will then meet divisions of the IInd and VIIth Corps, who must arrest him, whilst von Werder moved down on his rear.

(3.) He may attempt to reach Gray by Marnay. The division of the VIIth corps and Knesebeck on the right bank must hold him, whilst Werder again presses down on him.

(4.) Should he turn up the Doubs or to the XIVth corps, the IInd and VIIth would follow him northwards.

(5.) *Should he take the Ornans, Pontarlier Road, the advanced guards of all three corps must pursue him.*

(6.) In the event of his waiting under the guns of Besançon, he could be reduced by famine.

Having thus indicated the probable nature of the operations, General Manteuffel concluded his instructons with the usual proviso, that commanders were to initiate operations in accordance with their spirit, without waiting for his precise orders, in case circumstances should demand a sudden resolution.

Cases (1) and (5), viz., marches by roads east of Quingey did in fact occur, and we shall see how they were met presently.

It will be seen that all the hypothetical cases, except the (3rd), that which would have taken the French towards Dijon by Gray, demanded von Werder's movement towards Besançon, *i.e.*, down close to the Doubs. It was this case that that commander had however considered probable, and on the 24th, before receiving his chief's orders, he had moved to the westwards towards Rioz, only leaving Schmeling's division on the left bank of the Doubs between Clerval, Beaume les Dames, and St. Juan d'Adam. It is to be noted that von Werder was aware of great difficulties which would be met in marching through the forests of Chailluz and Chatillon, on the route Manteuffel suggested. Schmeling He had about 10 battalions, 8 squadrons, 6 batteries. I call attention to his position and to that of Debschitz with 7 battalions, 2 squadrons, 2 batteries at Blamont, east of Montbeliard, as a few days later, the absence of these divisions in the north of the Jura was like, but for other reasons, to have influenced the end of the campaign. General Debschitz, I may here state, had on the 23rd found about 6,000 of

Bressole's corps still in front of him, had attacked them, and captured 400 prisoners.

IInd Army Corps reaches Vaudrey, pushing patrols to secure Mouchard, the railway junction, where a slight combat took place.

VIIth Army Corps sends detachments to Myon, Chatillon and Port Lesny on the Loue, meeting the enemy in small forces. Patrols also communicated at Mouchard with the IInd corps. Von Werder, von Schmeling to Rioz and Verne.

25th. General Manteuffel having now heard of von Werder's march westwards, could no longer bring that General's corps down on Besançon, and it being useless and impolitic to interfere with his movements, desired him now to continue on the right bank, but to close in to Marnay, and free the VIIth corps from their duties there. The French were on both banks of the Doubs about Besançon, and needed watching.

IInd Army Corps stretched eastwards, occupying Mouchard and Villers Farley in force; patrols on to Salins, Arbois, Poligny, meeting enemy before the first of these places.

Willisen now in Dôle, having marched from Vesoul by Pesmes, is given Knesebech's brigade in addition to his own cavalry, and directed to destroy railway between Dijon and Dôle.

The line Gray to Vesoul was now in order, and relays worked on it, which was the more necessary, as the Langres garrison had began to show activity, and to molest the lines through the Cote d'Or.

The XXth corps, French, commences the retreat along the Ornans road.

26th. IInd Army Corps. The Salins Pass, which I have referred to, as being defended by two forts, was attempted by a brigade of this corps, but found to be too strong. Reconnaissance parties were sent round it, however, by mountain paths. 7th brigade of this corps at Arbois, 6th at Mouchard. VIIth corps about Quingey, patrols on to clear the banks of the Loue. XIVth corps to Marnay.

On the French side part of the 15th corps leaves Besançon for Ornans, and the right bank of the Doubs is completely evacuated by them.

It was this evening that General Bourbaki committed suicide; we have yet to learn the secret history of that ill-fated commander's relations with the Government and with his army during this campaign, and at present it is hopeless to attempt to form an estimate of them. Suffice it to say, that when on the 25th the Bordeaux Ministry received a cypher despatch from him, written the day before, and announcing that his last chance was gone, and that he had only to retreat to Pontarlier, and cross the Swiss frontier or surrender, they decided to supersede him and nominate General Clinchant, the commander of the XXth corps, to the chief command. The dispatch answering this crossed that conveying the news of the suicidal attempt, and was received at Besançon the 27th. These despatches must have passed through the German outposts.

27th. The events of this day are highly interesting. First of all, the XIVth corps, coming into position between Marnay and Besançon,

relieves the 14th division of the VIIth corps in sentry duty over the fortress, and this last division crosses the river at once. The entire VIIth corps is now about Quingey, with patrols out along the Loue; that river was undefended.

IInd Army Corps. General Fransecky had left 4 battalions of a brigade near Salins, and the other two brigades were between Mouchard and Arbois. His patrols out towards Censeau, Champagnole now told him of the assembly there of French troops. This appeared to indicate clearly that contingency No. 1, the march, viz., by Levier, Champagnole had begun, and General Fransecky set all his troops in motion to Arbois and on to Censeau; the troops west of Salins (the 4 battalions) were relieved by VIIth corps men, and then followed their own division. It will be seen that it was necessary to guard against any enemy issuing from Salins on to the Quingey-Arbois road.

The enemy thus signalled at Censeau and Champagnole, were indeed a mixed force of those French corps, which had the first start out of Besançon, and who to the number of 15,000 did get clear to Lons-le-Saulnier. But for the Salins forts and their resistance the previous day, the IInd corps would have been on the Levier, Censeau road, and probably intercepted these parties. As it was, the wider sweep round by Arbois saved them.

This day also, General Manteuffel having all his three corps well in hand, determines to rid himself of the Garibaldians at Dijon, who though for the moment restrained by Kettler, might come down at any time on his present rear at Dole. Indeed they were, as we shall see, on the eve of attempting this.

A division is therefore formed under General Hann von Weyghern, the Commander of the 4th division. It consisted of the Kettler division, already near Dijon, the Willisen brigade lately spoken of, a brigade and battery of the 14th corps, and the solitary battalion left at Mirebeau, in all $11\frac{1}{2}$ battalions, 2 regiments and 3 squadrons cavalry, and 5 batteries of artillery. The orders given were, that this division should attack Dijon, or act on the communications of the French there, and relieve the army in the Jura of all anxiety from that side. I shall allude to their operations, which resulted in the capture of Dijon presently.

This day the telegraphic communication was opened by Epinal and Vesoul to La Barre, near Dampierre, on the Doubs, relieving the post service from Chatillon.

The Bordeaux Government had not been idle spectators of the struggle going on in the eastern Departments; they had made considerable efforts towards provisioning Bourbaki's army—we have seen some of their trains, one of 230 cars, fall into German hands—and to raising the numbers of Garibaldi's forces. No less than 50,000 men were on that General's pay sheets at this time, though nothing like that number were present with the colours. For several days M. de Freycinet, at Bordeaux, had believed that only one full German corps had marched on Besançon, and that Bourbaki could break through this number of troops. But now, on the 27th, there was no longer any doubt as to the real situation, and in a note sent to General Clinchant

that evening, he was informed very accurately of the position of the German Corps. He was enjoined to make a last effort to break through and reach Lons-le-Saulnier. At the same time Garibaldi was called upon to move out from Dijon and march to Dôle and up the Doubs, so as to occupy the German corps. Furthermore, 8,000 to 10,000 men were sent up from Lyons to Lons-le-Saulnier, by rail, to co-operate with the Garibaldians.

28th. IInd Army Corps. 5th brigade to Poligny, its advanced guard towards Lons-le-Saulnier comes upon and is stopped by the advance of French troops (those dispatched from Lyons). 6th brigade to Pont de Navry (near Champagnole). 7th brigade to Champagnole, and patrols on to Nozeroy, who captured 50 waggons and many prisoners there. French also reported in some numbers at Les Planches; and in the middle of night (10 P.M.) General Fransecky, at Poligny, turned the 5th brigade and corps artillery out, and started with them for Champagnole, intending to push on Les Planches. General Manteuffel had, however, more correct information about the real numbers of the French that could be at that place, and in the night during the march Fransecky was directed by him on Pontarlier.

VIIth corps, now relieved of duty about Besançon, moved forward to Amacey, Deservilliers with the 14th division, and to Levier with the 13th.

29th. IInd Army Corps on to Censeau, dispersed some Mobiles about Nozeroy, and went into cantonments about those places. A patrol went to Les Planches, turned some dragoons out of that place, who had been sent *forward* from St. Laurent, being part of the Lyons division.

VIIth Army Corps. 14th division marches on Levier by the cross road, Amacey-Levier; a guard on to Chaffois, who had there a two hours' fight before gaining the village; a detachment to Sombacourt, who also had to fight for the village, which is on the main road the French had used and were using for their retreat. No less than 4,000 men were made prisoners this day. The outposts of the 13th division, wishing to cross the Loue about Ornans and feel for Schmeling, could not do so, as there were many French there, and the division followed the 13th division to Levier.

General Hann von Weyghern had decided on moving on Dijon by Pesmes and Gray, in order to join General Kettler, who was at Messigny, on the Dijon-Langres road, at this time. It appears that it had been contemplated to march by St. Jean de Losne and Nuits, to the south of the Dôle-Dijon Railway, but that it had appeared probable that the bridges over the Saone would be destroyed, and, moreover, though Dijon would be reached on its least defensible side, the south-east, yet it would be on the side remotest from Kettler's forces. As it was, General Hann was at Esserterne and Mirebeau on the evening of the 29th.

At the same time Garibaldi had moved with two brigades out from Dijon, on the Auxonne, Dôle Road, and on the evening of the 29th had his outposts on the line Varois, Auxonne, Mont Senne, Rolland. He himself was at Bourg. The rest of his troops were in Dijon and surrounding country, and in the Cote d'Or.

I have now accounted for the positions of all the troops engaged on both sides, except the 4th reserve division, General Schmeling, the detachment of General Debschitz, and the 6,000 men of De Bressole's corps, of whom we heard last on the 22nd, near Blamont. Manteuffel's last plan was that these German troops should come down on the Ornans road, and he had expected them at Etalans on the 28th. Had they been there then and been next day on the road Ornans-Pontarlier, numbers of the French must have laid down their arms.

At that time, however, General Schmeling was far off; in fact, on the 27th he had received the most pressing information from Debschitz of large numbers of French in front of him; this was incorrect; but he hastened off to St. Hypolite, von Werder leaving him general instructions to act for the best. Arrived there, and meeting Debschitz, it was found that the enemy were only De Bressole's men struggling down through the Jura, and Manteuffel now sending express orders to him to come at once to Pontarlier, he started down the Jura in forced marches, having, however, lost what might have been all-important time.

I must now allude to the effect of the Paris fall and capitulation, and the consequent armistice on the war in the east. It is a point on the importance of which on the operations in the Jura, German and French writers thoroughly disagree, and in which I am disposed to agree with the latter to a great extent.

To the comprehension of the question, I have marked on the map the positions of the armies on the evening of the 29th.

French Side.

Columns between Besançon, Ornans, Pontarlier, the bulk in Pontarlier.

15,000 men on the road Les Planches, St. Laurent, or farther south still, being a mixed body of the XXth corps, XXIVth corps, and Cremer's division, with that General in person.

The Lyons division about the same places.

Stragglers in the Jura coming down to Morteau.

Garibaldi with part of his force on roads to Auxonne and St. Jean de Losne, the remainder in and about Dijon.

The garrisons in Belfort, Langres, Auxonne, Besançon, intact.

German Side.

IInd Army Corps in Censeau, Nozeroi, detachments in Les Planches.

VIIth Army Corps about Levier, detachments in Chaffois and Sombacourt.

XIVth Army Corps about Besançon.

General Hann von Weyhern in Mirebeau.

General Schmeling about Sancey.

General Treskow besieging Belfort.

General Debschitz about St. Hypolite.

One road only, Pontarlier-Mouthe, was yet quite open to the French, and this road was within easy reach of Les Planches, and only 10

miles from the IInd corps at Censeau. Nevertheless it seems possible with fighting and marching, holding Pontarlier with a rear guard against the VIIth corps, and with the aid of the men already about St. Laurent, that a great number of the French would have got clear next day.

Next day, however, by an extraordinary mistake, the movements of the French troops were suspended. The reason was this:—

The armistice was signed at Paris on the 28th. Without entering upon its general terms, I will only summarise the last article.

The Departments of Cote d'Or, Doubs, and Jura are for the present excluded from it (the armistice); siege of Belfort (Haut Rhin) to proceed also.

General Manteuffel was informed so by telegraph on the 29th, at 5 P.M.

The Bordeaux Government was also informed by their colleagues in Paris of the armistice, *but not until five days later*, extraordinary as it may appear, of the last article, and then from a German source. Therefore on the 29th both Generals Clinchant and Garibaldi were only informed from Bordeaux of the armistice in general terms, and ordered to suspend all operations.

30th. This day, therefore, we have the spectacle of the Armies acting under different instructions.

General Clinchant sent repeated messages to Manteuffel to claim the benefit of the truce; that General and his subordinates refused all these, and continued operations without a moment's delay.

Therefore the IInd Army Corps attacks Frasne, and captures it and 1,500 prisoners. Manteuffel moves in person from Arbois to near Levier by a cross road to the north of the Salins Pass, which was still occupied the French. Same day the Besançon garrison claim a suspension of hostilities from von Werder, and Garibaldi from Haun von Weghern; both were refused.

31st. VIIth Corps occupied the Ornans-Pontarlier road, up to the Drujeon rivulet, near Pontarlier.

IInd Corps closed in on Pontarlier, about Dampierre; a detachment of 2½ battalions, and 1 battery more on to the Pontarlier-Mouthe road; the enemy found in some force, about St. Marie and La Plencie, on that road, and forced back; 1,500 prisoners were taken, and the passage closed.

Continued demands were received from Clinchant for an armistice, and refused.

On this day General Clinchant issues his last order on French territory to his troops. He announced the error of the Bordeaux Government, by which he had lost the previous day, for retreat, and also his intention of seeking shelter in Switzerland.

1st February. Next morning, at 5 A.M., the convention to that effect was signed with General Herzeg, the Commander of the Swiss Federal Forces, and the operation of crossing the frontier immediately began.

I need only allude slightly to the remaining operations. The VIIth and IInd Army Corps were all up early in the morning and occupied Pontarlier. General Schmeling also arrived, *viâ* Doubs.

The French held a rear guard position at St. Cluse, near the frontier, where is a deep gorge closed by two hill forts, and a considerable fight took place with them, the forts being only occupied by the Germans late in the day. This was the last event of this campaign.

Garibaldi had returned to Dijon from Auxonne, and commenced the movement of his men to Lyons, and this day, the 1st February, General von Werder occupied Dijon at 8 A.M., after but little fighting; five weeks after von Werder's Baden division had quitted it.

The general result attained was that 2 eagles, 12 cannon, 7 mitrailluses, 15,000 prisoners remained in Manteuffel's hands; 80,000 or 85,000 men were driven near the Swiss frontier, and only about 15,000 of the Army of the East effected their retreat to Lyons.

It was not therefore without reason that General Manteuffel in his order of the day of the 2nd February could say that "the marches and "combats amidst the snow and ice of the High Jura had not been "fruitless," whilst his subsequent letter and actions showed how fully he had appreciated the brave resistance made by the French troops; in this all will be disposed to join, and will show in the regret that so much valour should have had to struggle against so many defeats in organization and management.

Belfort capitulated on the 15th February, the garrison marching out with all the honours of war and with their archives.

And now having concluded this imperfect sketch of a small section of the great war of 1870–71, I would venture to make two or three deductions that suggest themselves from this set of operations:—

(1.) Here, as at Paris and Metz, a fortress with detached forts is laid siege to, and the curious, and to the engineer, somewhat anomalous result is seen of a garrison of equal strength to that of the besieging army being unable to break the investment or prevent the advance of his siege works. It will be urged that the troops inside were, at Belfort, of very different calibre to those outside, and this can readily be admitted; but there was a resolute and skilful commandant, several excellent officers, and a sprinkling of good troops in the garrison, and yet they could only occupy an equal number of besiegers. It appears from these three experiences that, although the besiegers are kept at a great distance by detached forts, on the other hand it is very difficult to make sorties unless roads have been specially laid out for the purpose. The extent of country to be traversed is great, and the enemy is not, as formerly, seated on a level glacis, but entrenched in villages and amidst broken country, where his real strength is concealed, and the march out to which takes a long time and precludes surprise.

(2.) On its becoming a necessity for the Badeners at Dijon to retreat before the Army advancing from Bourges, a bold *offensive* is assumed, and the heads of the enemy's columns are vigorously attacked at Nuits, on the 18th December, though the country taken is not held. This action gave time for an orderly evacuation of Dijon.

(3.) The same description of an offensive and defensive operation is repeated at Villersexel on the 9th January. Von Werder might have withdrawn at once to his position on the Lisané; he prefers to await his enemy about Vesoul and to attack him from a flank, again checking the column and compelling a greater concentration, besides the loss of two days at least, days of paramount importance. In both these cases the Germans *advance* to their battle-fields, thus securing the prestige of the attack.

(4.) Of a similar character is the very bold attack by General Kettler on Dijon, 21st to 23rd January. He was fully aware of the great odds against him, 30,000 men and 60 pieces of artillery at least against his 5,000 men. Under such circumstances he could hardly hope for a positive success. It was rather what chess players call a "gambit," the loss of a piece to strengthen the other moves.

(5.) The battle of Belfort or Hericourt was one of the few defensive actions fought by the Germans during the war, and showed that they fully understood that portion of tactics. It was converted into an offensive fight on the third day, and was very promptly followed up.

(6.) The slowness of movement of the French must be noted. They took three weeks to arrive at Villersexel from Bourges, having command of railways up to Clerval. We must do credit to the energy shown in collecting them at Bourges so soon after the disasters at Orleans, and in the efforts made to feed them subsequently.

With a good organisation the French might have been at Villersexel on the 1st instead of the 9th January, and fought the battle of Belfort on the 5th instead of the 15th. It will be remembered that the battle of Bapaume in the North was only fought on the 2nd January, and that a great sortie from Paris was expected about the same time, as also that General Chanzy was not defeated at Le Mans until the 10th January. It seems probable, therefore, that neither General Manteuffel in person or the IInd corps could have been on the scene in the very early days of January; and Bourbaki would have had time to rest before Belfort and renew his attack, or to retreat in an orderly manner on Lyons. The French were greatly in need of cavalry and of a good staff, neither of which can be supplied by ever so great an amount of energy at short notice, and of an effective railway organisation.

(7.) General Manteuffel's operations seem remarkably bold and well thought out. He changed his base in the most perfect manner during the advance, and his information was generally very good. Von Werder and Schmeling's slight departures from his views probably saved bloodshed round Besançon, where another battle and another Sedan might have occurred, had they moved down on it as was intended.

(8.) Garibaldi did not show the energy of former years, or the skill in managing a partisan warfare. He quite failed to carry out

the duty of protecting the flank of the French advance to Belfort, and allowed himself to be easily deceived as to the strength of the force immediately opposed to him. Nothing is more melancholy than to read of the pæans of victory sung by his staff and the Bordeaux Government over the imaginary repulse of 70,000 men before Dijon, and it is with no small surprise that one finds this and other fictions repeated in edition after edition of the semi-official books. General Cremer had strongly wished to take the duty of the guard of the Côte d'Or. Had he done so, and rallied to him the inactive garrison of Langres, there would have been some rough work about Is-sur-Tille and Langres on the 15th, 16th, 17th January, but at the same time Bourbaki would have lost the small gleam of victory vouchsafed to him before Belfort, the capture of Chenebier on the 16th January being due to Cremer's corps.

(9.) After the 17th January Bourbaki could only have saved his army by rapid marching; Dôle lost, and the railway to Lyons lost to him by the 23rd. He had played a gambler's stroke, and left the Saone and Doubs practially undefended. Such marching and such energy was not in the French or their commander at that time. The former unclothed, unfed, and the latter thoroughly dispirited, they could only collect in disorder about Besançon, and it was at the last rather by chance than their own efforts that they were saved capitulating on French territory.

(10.) Lastly, it will be noticed how difficult the advance of the Germans from Dôle through the Jura was; how easily the road was barred as at Salins, on the banks of the Loure, and what confused reports they got of the number of the enemy at points quite close to them, as at Champagnole and at St. Hypolite. The minor operations of this campaign have been but slightly touched upon, and it is to be hoped that some day we shall have fuller accounts of these. It would be of immense interest could we learn from the Germans how they fed their forces, in what degree by requisition, how far by train supplied. Perhaps some one conversant with these details will some day enlighten us on these and other points of which we are at present ignorant. All the details of German organisation are of interest, and none more so than those carried out to the end of the war when Generals, Staff Officers, and men were in full possession of their rare practical experience.

Evening Meeting.

Monday, March 3rd, 1873.

ADMIRAL THE RIGHT HONOURABLE THE EARL OF LAUDERDALE, K.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 17th February and 3rd March, 1873.

LIFE.

Merceron, Henry, Ens. H.A. Company.

ANNUAL.

Rayner, W. S., Captain 5th Bl. Lanc. Militia.
Newington, C. M. H., Lieut. 22nd Regiment.
Scott, John, Captain 22nd Middx. Rifle Volunteers.
Ashburner, F. J., Lieut. 2nd Dragoon Guards.
Rentzsch, Geo. H., Surgeon 1st Middx. Art. Volunteers.
Holliday, Joseph F., Lieut. 12th Cheshire Rifle Volunteers.
Hunt, J. M. F., Lieut. 1st London Art. Volunteers.
Salmon, Nowell, Captain (V.C.) R.N.
Bower, G. J., Lieut. R.N.
Battye, Montague, Sub-Lieut. 59th Regiment.

LESSONS FROM THE "HOTSPUR-GLATTON" EXPERIMENT.

By NATHANIEL BARNABY, Esq., Chief Naval Architect, Admiralty.

THE experiment made on the 5th July, 1872, in Portland Harbour, was designed to test the endurance of certain parts of the turret arrangements in the "Glatton," when exposed to fire from a 600-pounder gun at 200 yards, with charges of 85 lbs. of pebble powder.

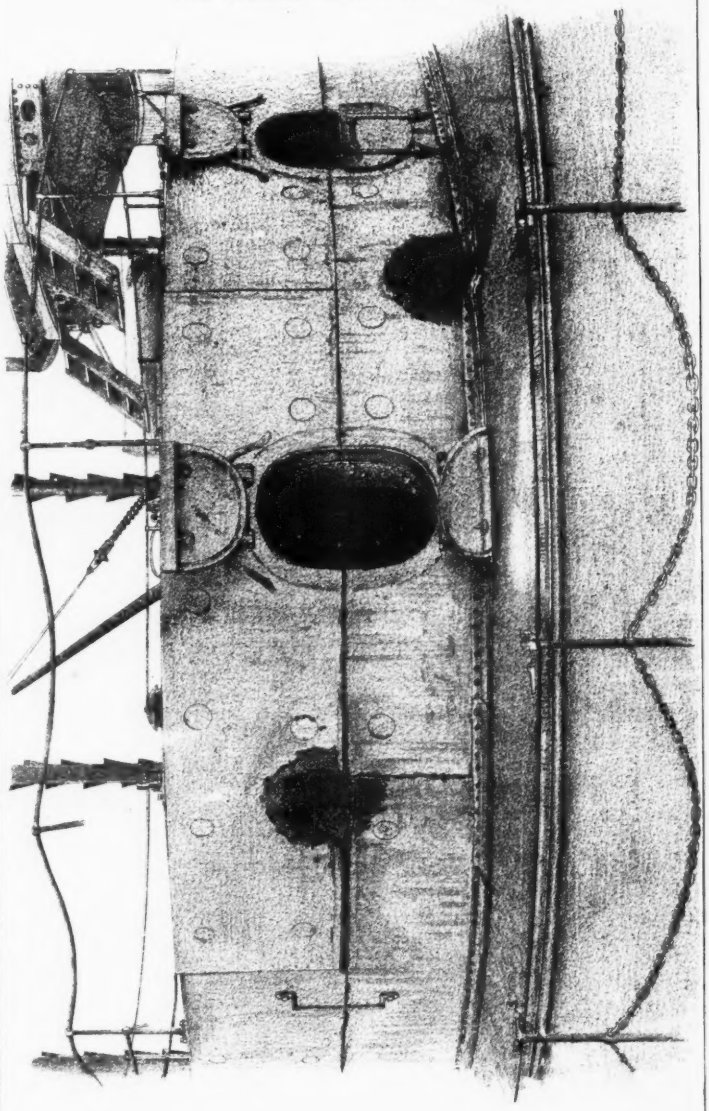
The experiment was not made for the purpose of ascertaining what power of resisting penetration the turret armour possessed, but to set at rest certain questions which had been often raised and which nothing but such a trial could settle.

Of these the most important were:—

1. Was the turret capable of receiving a blow from a heavy projectile at short range, without communicating such a shock to the turning gear as would disable this gear?

2. Would not a shot striking at the junction of the turret and the glacis, lock the turret and prevent it from turning?

THE GLATTON'S TURRET
From a Photograph taken in the Dock at Chatham



J. Jobbins

I do not think that mechanicians who had given careful study to the matter before the experiment was made, gained much by the experiment beyond a confirmation of their opinions.

It was proved, as was certainly anticipated by the Constructors of the Navy, that the shock which was communicated to the turning-gear was too small to do it any injury.

With regard to the second question, it showed that a very trying shot did not lock the turret. It did *not* show that no shot would lock it. Those who had but little confidence in turrets, pointed out that, notwithstanding the successful manner in which the turret had withstood the glacis shot, the next shot might lock it, and they would have been entitled to continue to say this after any number of blows had been struck. Those, on the other hand, who considered how much pains had been taken to prevent jamming by a glacis shot, held that it would be impossible to aim a blow more likely to lock the turret than that which had accidentally struck the glacis, and that nothing would be gained by further attempts to hit the junction. Are these then, it will be asked, all the lessons to be learned from the experiment? because in that case, it would appear, that while the outside public were inspired with certain confidence in turrets, which they did not possess before, official people have gained very little. It is at this point, that any interest which my paper may contain will commence. There were other lessons which we needed to be taught, and so far as I have learned them, I will communicate them to you, in compliance with the request of your Council.

We have been told by Captain Dawson, that one lessson to be learned is, that our system of rifling our guns is bad, and that our naval artillery is not what it ought to be. As I am not an artillerist I shall leave that matter in his hands. My business is:—

1stly. To find out just what mischief can be done by the guns, and to guard against and limit it to the fullest possible extent in the structures which have to withstand the fire.

2ndly. To devise the best possible platforms and batteries for the most powerful guns which Woolwich can produce.

You may say to me, that if the Constructors confine their attention to Woolwich productions, they will remain in ignorance of the more terrible powers of foreign guns, and will produce ships with less offensive power than they ought to have, if the proper weapons were supplied. You may even go on to say, that we should insist on having the more powerful foreign guns tried at Shoeburyness. I am contented to note the objection and the recommendation, and to pass on.

The facts are, that a Woolwich gun planted two 600-pound shot in the "Glatton's" turret, and they did the damage to the plates struck, indicated by the diagram (see Plate xiii), and very serious damage it is. I shall not stop to describe it, because it was witnessed by many here, and is well shown by the diagram.

What I am concerned that you should notice, is the almost perfect state of the inner shell or skin of the turret, as ascertained after the armour and wood backing had been stripped off.

This skin and its protective coverings had done their work well, and the energy of the shot was completely absorbed by them without perforation. When it is remembered that the blow was delivered on a space of about three-quarters of a foot, by a pointed projectile weighing 600 pounds, travelling at the rate of about 900 miles an hour, we may well be satisfied with what Chatham and Sheffield together can do in the way of target-making.

But we now come to the imperfections. The fastenings were not all that could be desired. The result of the first blow upon them was as follows:—

A piece of the head of a bolt attaching the armour plate to the backing, 4½ inches in diameter, having been struck by the shot, was broken off 9 inches from the outer end, and thrown out to the front towards the "Hotspur." This piece sunk in deep water. Had this been all, there would have been but little occasion for complaint, but unfortunately, the inner end of this same bolt broke off also, and being projected violently forward, it struck the inner lining of the turret, forced it off from the frames, and passing through the rent, landed on one of the guns. The inner lining had been fastened with small screws tapped into the frames, and of these 52 were broken and were lying about the turret. Three screw-nuts fastening the wood-backing and some tapped screws in the skin-plating were also broken off. After all the damage had been noted, the steam turning gear which had been connected during the trial, and the hand turning gear were both worked and found to be in perfect order. The right gun was then raised and lowered by the hydraulic apparatus, and no damage whatever was visible to the turret or guns.

After the second shot, it was found that other screws in the lining were broken, the heads being projected forwards into the turret.

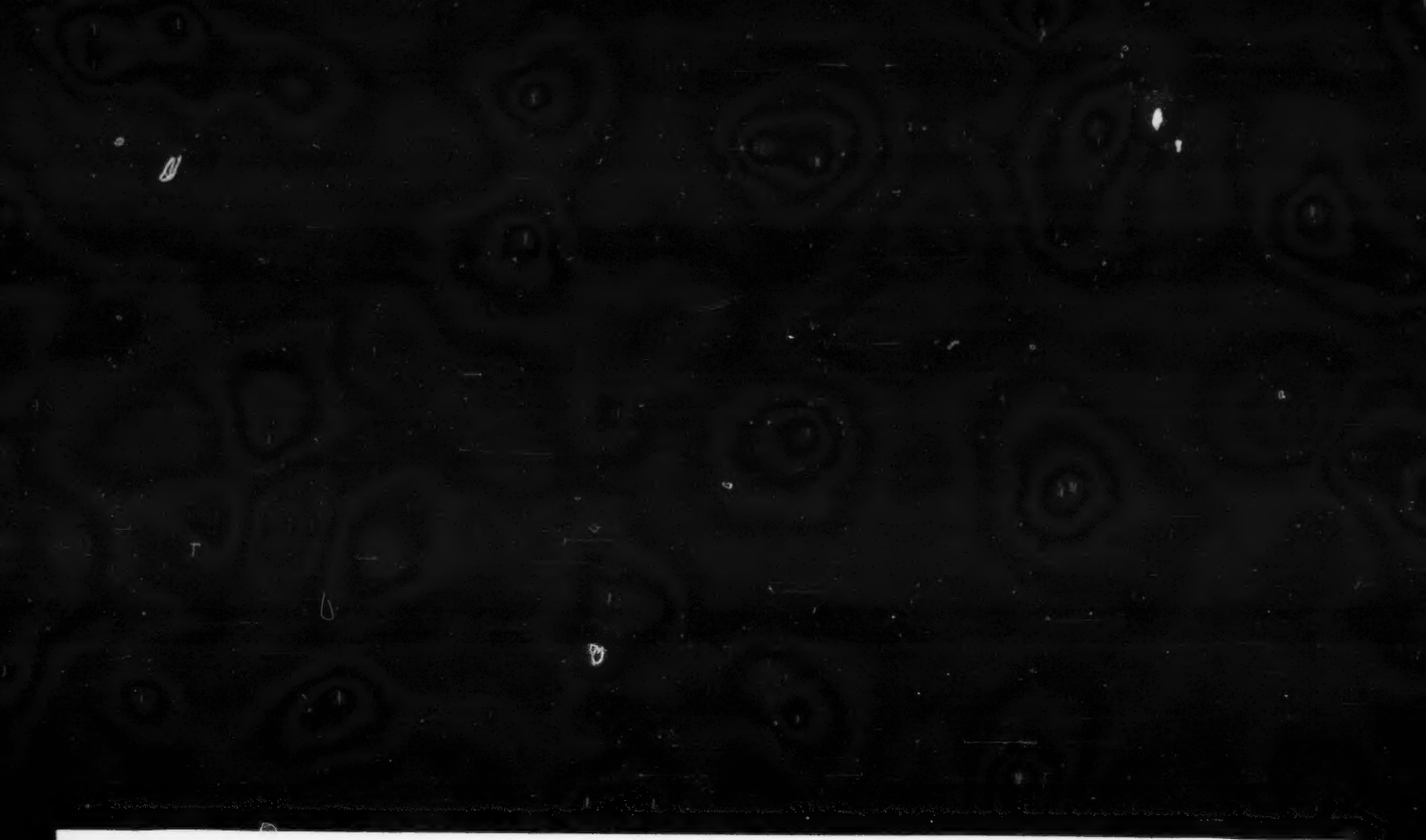
After this, the turret was again revolved by hand and steam, and the guns within it were loaded and fired out to sea with battering charges and Palliser shot.

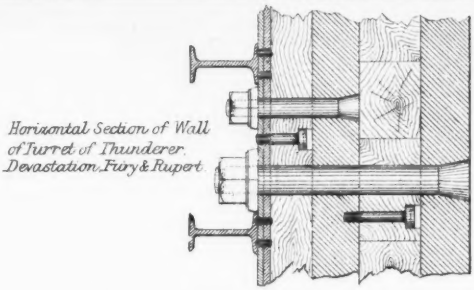
Although many tapped screws and rivets were dislodged and broken, they were found chiefly on the floor of the turret close to the injured part, apparently having dropped from their positions. There were no marks or scratches either on the guns or on the paint work of the turret inside, as might have been expected to be the case, had the nuts or rivets flown about with violence. The exception to this was the nut of the armour bolt. Had the guns been manned by their full complement of men, some casualties would probably have occurred, but the Committee considered that there was no reason to believe that such casualties would have been serious.

It is, in fact, not improbable that had the turret been lined with matting within the iron lining, nothing but the nut of the armour bolt would have found its way through.

In view of this breaking of the bolts, it became necessary to consider whether some remedy could not be devised.

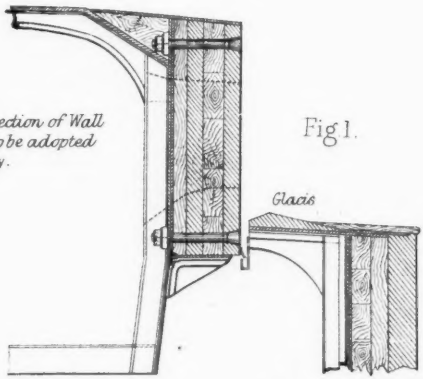
I may perhaps be told that if, instead of using elastic cup-washers on the points of the bolts, we had adopted some other form, the points would not have broken.





Horizontal Section of Wall of Turret of Thunderer, Devastation, Fury & Rupert

Fig. 2.



Vertical Section of Wall of Turret to be adopted in the Fury.

Fig 1.

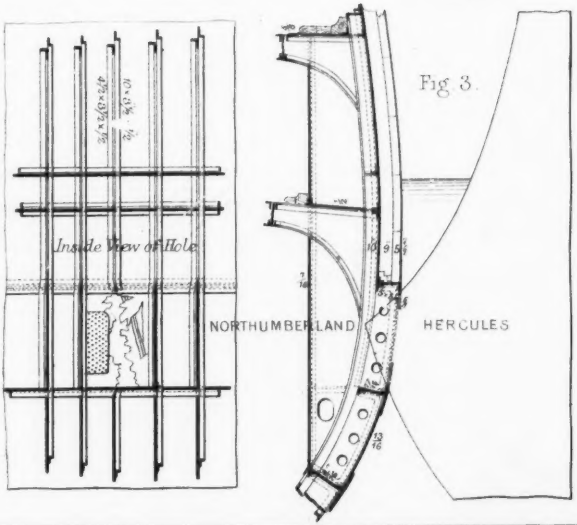


Fig. 3.

J. Jobbins

I do not propose to discuss this matter, but would merely say that a set of trials are now going on at Chatham, to determine by a percussive test the relative values of different plans suitable for naval purposes. The very excellent plan in use by the War Department is not included among them, because it is not suitable for ships.

Assuming as we do that whatever form of bolt is adopted, such a blow as that received on the "Glatton's" turret would have broken the inner end of it, we have adopted the device shown in the diagram, (Plate xiv, fig. 1,) by which the risk of having such broken points projected into the turret is greatly reduced. This plan requires us to make the turret-armour in two thicknesses of the full depth of the turret, as in the turrets of the "Thunderer," "Devastation," "Fury," and "Rupert." See diagram (Plate xiv, fig. 2).

To prevent the *heads* or *points* of rivets being knocked off and projected into the turret, continuous screws are used without heads or points. There are other details in which improvements have been made that may have importance in practice, but which do not appear to possess enough to justify me in bringing them to your notice.

You would doubtless prefer that I should say something as to the lessons taught at Portland, affecting the general usefulness of the turret as a part of the machinery of a ship-of-war, and I am willing to do so.

I think it may be said that the popular confidence in the turret has been increased, and I hold that inasmuch as there was a good deal of unfounded prejudice against it which the trial helped to remove, this increase in the popular confidence is just and right. But there was another feature in the experiment which was very suggestive. I witnessed the firing from on board the "Hotspur," and I saw the care with which the ships were moored at 200 yards range, and the pains taken to get the precise amount of elevation supposed to be required (21′). Four sighting shots were fired, and then, although there was no wind, and scarce a ripple on the water—the first shot at the turret itself, hit the sighting bull's eye, placed $28\frac{3}{8}$ inches above the point on the turret which it was intended to strike.

The next shot, fired with 15′ elevation, hit the turret, but at a lower point than was intended, as it struck near the joint of the armour; and it hit also on one side of the centre line between the ports, so that it came upon one of the bolts which it had been intended to avoid.

The next shot was intended to strike the turret about 17 inches above the deck, but instead of doing so, it struck the deck, indented it, cracked the glacis-plate, and then did its best to lock the turret by forcing its way $13\frac{1}{2}$ inches into the armour and stopping there.

This inaccuracy was probably due to a slight motion in the "Hotspur," only perceptible upon very close observation.

With this amount of inaccuracy, under circumstances the most favourable that can be conceived, what inaccuracy and chance shooting there must be on the open seas, when the gun and gunner are being rolled through vertical arcs not of minutes but of degrees; when the ship is also lifting and then lowering the gun bodily several times in a minute through feet of vertical space, at one time adding to

the upward motion of the gun produced by rolling and then abating it, so that in allowing for this motion in the shot when it leaves the gun, the gunner must at one moment allow for roll and heave together, and at the next for the difference between the two? I am not able to say—I suppose no one could—how many times in a minute the "Monarch" or "Captain" would have been able to have fired with turret guns in the heat of an action, but a good test of rapid firing at a large mark at about 1,000 yards has been made with the "Monarch" and "Hercules."

In five minutes the "Monarch" fired twelve rounds from her four 12-inch guns—*i.e.*, three rounds per gun. The "Hercules" fired seventeen rounds in the same time from her broadside of four 10-inch guns—*i.e.*, 4¼ rounds per gun. The proportion of hits to the rounds fired, was also rather more than 6 per cent. in favour of the "Hercules."

Taking the number of rounds per gun at three in five minutes, it is said by many persons that in an action this would be also the number of rounds per turret, as the two guns would nearly always be fired together. If this were so, that would be little more than one discharge per minute from the turrets of a ship like the "Monarch" or "Captain."

Having settled for ourselves what we will estimate the rate of firing to be in a turret in an action and the risk of missing, let us now bring in the further consideration that to protect two 25-ton guns as they are protected in the "Glatton," you must devote the weight of 6 other pairs of 25-ton guns to make the turret, *i.e.*, given 14 25-ton guns, you must take the weight of 12 to cover the other two; or, to put the matter more fairly, given two pairs of 25-ton guns, with carriages, slides, and full chase allowance of shot, shell, powder, and stores, we must take one pair of guns and its ammunition to make a turret for the other pair, so that the luxury of a turret armament, as compared with unprotected guns, obliges us to give up half our guns and ammunition. Observe, I do not compare turret-armour with broadside-armour; I am simply shewing what we have to pay for armoured defence on the turret-system in actual weight of ordnance.

I will ask you now to cross the Channel and see what our quick-witted neighbours are doing; and I must say of the French naval designers, that in my opinion they are second to none in ingenuity, skill, and enterprise in these matters.

Now, how many turrets of the "Royal Sovereign," "Monarch," "Captain," and "Glatton" type has France introduced into her Navy?—Not one.

I ask myself why this is, and I imagine their answers to be:—

1st. We have no ships in which we should think it wise to dispose a weight equal to that of the guns and their ammunition as a cover for such guns.

2nd. When we desire to fire at an enemy, we like to see him, and we stand a better chance of doing so, when we and our gun are not shut up in a box.

3rd. In a masted ship your turret does not give an all-round fire; you cannot fire either ahead or astern.

H M S "TÉMÉR

WITH ENCLOSED BATTERIES ON THE MA
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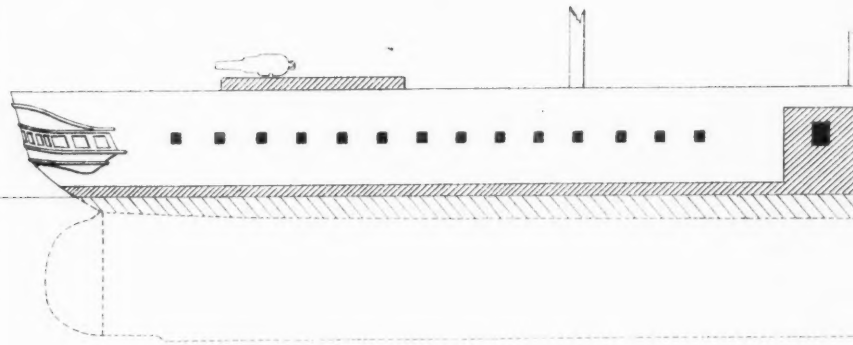

PLAN OF UPPER AND
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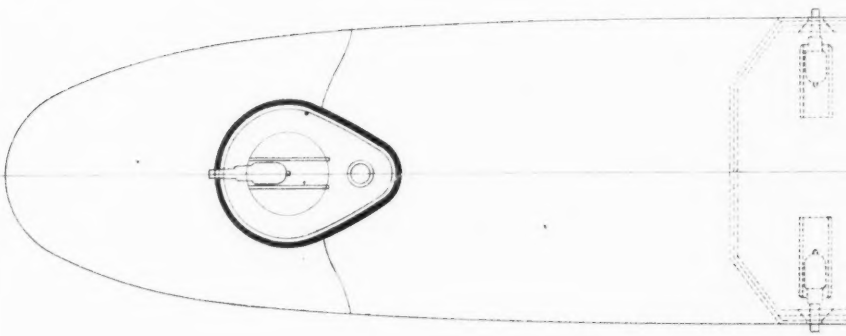

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S ON THE MAIN DECK AND BARBETTE
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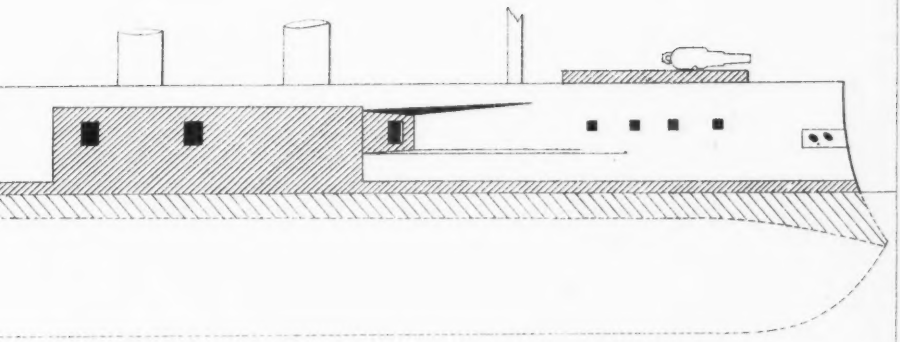
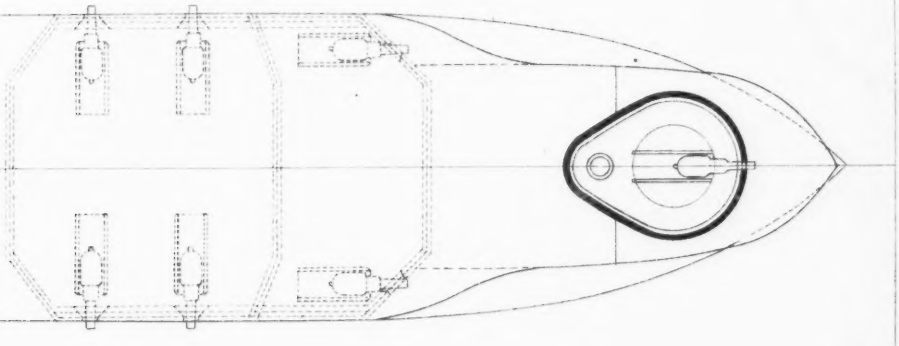


UPPER AND MAIN DECKS
ent the Guns and Bulkheads on the main deck



ded parts represent armour

J. Jobbins

DEFECTIVE ORIGINAL.

We prefer a plan which is about half the weight of yours; in which we can always keep our enemy in sight, and fire when we can make sure of hitting him; in which we are not embarrassed with smoke to the same extent as a turret is, and in which we can fire right ahead and right astern. That plan is the "barbette battery."

I imagine those to be their answers.

We must not however lose sight of the disadvantages of their plan. They are—That the gun is exposed to fire, and may be dismounted or otherwise disabled by a shot or shell which would not enter a turret, and that there must be a certain amount of exposure, on the part of the gun's crew, to fire from musketry and case-shot in a close action. This latter is, however, reduced to a minimum by the adoption of breech-loading guns, so that the loaders are protected by the gun itself.

I have said that this mode of mounting heavy guns involves about half the weight of the ordinary turret. This may be seen from the illustration of it given in the accompanying diagram, in which barbette turrets are placed at the bow and stern of the ship. (*Vide* diagram of Téméraire.)

According to what I assume to be the French view, which I have placed before you for consideration, every masted *turret* ship must necessarily be an extravagant ship, *i. e.*, she must be weak for her size and cost.

Persons who take this view, would admit the success of the "Monarch," for example, but would consider that some £400,000 is too much money to pay for a ship with only two turrets and only 7-inch armour for the protection of her hull.

I give you no opinion of my own on that matter, but I simply throw out these suggestions, which naturally arise from a consideration of the slowness of fire in a ship with turrets, and the general uncertainty of hitting when you do fire in a naval engagement.

In conclusion, I should like to put before you a few questions for your consideration, as to the use and distribution of armour in ships of war.

1st. Is armour retained in ships of war to protect the gunners or to protect the ship?

2nd. If for both purposes, in what proportion should it be distributed? should the armour in front of the guns be one-fourth thicker than that protecting hull, boilers, and magazines, as it was in the "Captain"?

3rd. Or, remembering that men are of no use in an action without a ship to fight in, but that a ship may remain an efficient engine of war with neither guns nor gunners—remembering this—ought we to keep the hull afloat at all hazards to life and limb from shot and shell?

4th. If we stint the armour on the hull in order that we may thicken that upon the battery, will not a wise enemy, if he happens to have guns enough, fire broadsides into the hull-armour in order to endeavour to reach the machinery or magazines, and fire, at the same time, with light guns at the gun-ports.

5th. If you decide that the hull must have the preference, and should have thicker armour and surer defence than the guns and gunners, it may be that you would go so far as to say that, in an extreme case,

where the weights were strictly limited, you would even leave the guns without armour, in order that the hull may be made secure.

6th. The abandonment of armour protection for the guns leads at once to an increase in the power of the artillery, because the increase in the number of guns, presents but little difficulty as to weights, if they do not require to be armoured. Do you then consider that when we have a ship which has been so armoured as to be practically unsinkable by shot; in which the boilers and magazines have been made secure; and in which the number and power of the guns have been so increased, that a concentrated broadside may mean six or seven 18-ton guns—all directed at the same spot, and fired by wire at the same moment—do you consider that such a ship would stand a fair chance in fighting with an enemy with penetrable hull plating and few guns,—but those guns protected by armour?

7th. If you think she would, let me add, an armoured traverse at each end of the gun-deck, with ports in it for right ahead and right astern fire, and let me add also an upper deck armament of light guns to fire at the ports of the enemy, and she will probably commend herself still more to your judgment.

Such a ship as I have sketched, may some day meet with favour from those who have to fight the ships. They must be consulted to the fullest extent; and I do not think that such a ship should be forced upon the Navy as an armoured ship to fight other armoured ships, until the sailors are fully satisfied.

The Russians are already doing something of the kind. They are armour-plating the hull of some ships of about the "Raleigh" class, and placing a narrow band of additional armour in front of the gun-pivots, but they intend apparently to employ these ships against unarmoured ships only. If they fulfil the intention of their designer, they will have a manifest advantage over unarmoured ships, and if they have sufficient speed to bring the unarmoured ship into close action, their chances of destroying her will be considerable. But suppose two such ships, both protected in the same way, should meet, we should then probably have a *close* action between them, for, being equally protected, they would not think it creditable to avoid an engagement. We are thus brought by another road to the point we had reached ourselves, in which we have a close engagement between two ships having armoured hulls and unarmoured batteries.

I believe that the contest between broadsides and turrets will settle itself eventually in this way. The increase in the power of ordnance will drive us to thicker armour, and we shall concentrate it upon the only vital parts, viz., the floating and the motive power.

The CHAIRMAN: I hope that some gentlemen present will give us the benefit of their opinions upon the points raised by Mr. Barnaby in his very interesting lecture. From the trials that took place with the "Hotspur" against the "Glatton," there is no doubt that the shot from the 25-ton gun, at that very short distance, was brought up by the turret of the "Glatton." But the chief point that we all wished to have decided was, whether a shot coming in just above the flange of the turret on the deck, would stop the working of the turret. Now that second shot fired did not stop the working of the turret, because it was fired at so short a distance point-blank; the shot being a pointed shot it naturally did not turn down,

but went straight in. But if that shot had been fired from a height, or at any ordinary distance, 500 or 600 yards, it would have had a small elevation, and would have struck the mark with the point rather inclining downwards. Probably that would have altered the question entirely. If the point had been turned down it might have shown a very different result. With regard to the turrets, it must be borne in mind that in firing against a turret you always get a direct shot. If you are near enough to hit your mark, your shot is always a direct shot. But it is not so in a broadside ship; you never get a direct shot without you are broadside on. With the turret it does not matter how the ship's head is: if you are near enough to hit the point you aim at, you will always get a direct shot. Consequently the turret is at a disadvantage in that respect.

Commander W. DAWSON, R.N: My lord, as I have been alluded to in the paper, I venture to rise to open the discussion. Those of us who had the advantage of hearing Mr. Barnaby's former paper in this Institution, came here with very large expectations as to what we should learn, and I think I am expressing their feeling when I say that we are not disappointed. A more able and, if I may say so, a clearer and more dispassionate paper I do not know that I have ever heard in this Institution. With the mass of the lessons drawn, I thoroughly concur. I am particularly thankful to find that the Controller's Department of the Navy have come at last to the conclusion that ships are built to carry guns; because the offensive powers of successive types of ships have been gradually dwindling down to a vanishing point. Whilst the "Northumberland" carries 261 tons of ordnance, the "Sultan" carries but 194 tons, the "Swiftsure" and "Vanguard" classes 139 tons, and of the two ships experimented upon at Portland, one, though of 4,800 tons, mounts but two guns of the united weight of 50 tons, and the other ship, though of 4,000 tons, mounts but one gun of 25 tons weight. That offensive power is now to be considered as of some importance is, I think, a very satisfactory conclusion. It is very gratifying to find that in future our ships are to have a fair proportion of guns to fight with.* I thoroughly concur with the conclusions of the lecturer that the great defence of all ships is the ability to hit your enemy pretty hard and often, and, if you hit him hard and often, I think you may withdraw from the gunners some of their present armoured protection. Still, I think the gunners do want a little protection, and I look rather aghast at those bow and stern guns mounted up in the air without any covering whatever, when I remember that small arms can be sighted for pretty accurate practice at 900 or 1,000 yards, and that all good naval actions must be fought certainly under 1,500 yards. Therefore I think I should like to see light cover of some kind. (Mr. BARNABY: There is.) If you would only put a canvas screen round those tower guns, I should be very thankful for it; I mean a cover from sight rather than from shot. The broadside guns must be used at close quarters, and under all conditions of action, and require, therefore, more substantial cover. But the absurdity of putting a small patch of 14-inch armour a few feet square, and then shutting your eyes like the ostrich, and fancying the enemy is going out of his way to aim specially at that small 14-inch patch, was very clearly shown to those who witnessed the difficulties of hitting the turret at Portland. Our naval architects have laboured hitherto under a very great disadvantage in devising the novel structures of the last few years. They have been deprived of the advantage of intelligent external naval criticism as they have gone along. They have been obliged not only to construct the ships, but almost to tell naval men how to fight them. Being without this cultivated, intelligent, independent, and experienced professional criticism, external to the Admiralty, which they have a right to expect from the navy, they have been obliged to go, as it were, out of their own department of constructing a ship, and we must not be surprised

* This observation referred to the admirable principles enunciated by Mr. Barnaby, not to the design of the new ship exhibited on the walls. The new ship is designed to carry only 158 tons of ordnance, whereas even the old "Warrior" carries 202 tons of artillery, and the "Northumberland," 261 tons. So that, as to powers of attack and defence, the latter vessel would be much preferable, if her weight of ordnance were only concentrated into fewer perforating pieces.—W. D.

if there have been some mistakes as to the fighting capabilities. On the other hand, we must acknowledge, as naval men, that if we have given very little assistance to architects in the construction of our ships, they have at least succeeded so well in the generality of them, that the whole world is coming to England in order to copy the designs of British architects. Now, my Lord, I shall be expected perhaps to say something as to the "'Hotspur'-'Glatton' Experiment," having read a paper at another scientific institution on the same subject. Of course British armour is intended to meet foreign guns; and foreigners, though so ready to copy British ships, do not copy British guns. It will, then, naturally be asked, "But what will foreign guns do as compared with British guns?" My answer is that we do not know. All the information I can get with reference to foreign guns comes filtered through a very suspicious source, and I am not prepared to believe all that is so said, without an examination of more reliable data. The Germans appear to me to be a very intelligent warlike race, and not to be a very moneyed people; and I suppose they know a good weapon when they have tried it, and I do not imagine that they would pay double the price for guns which have only half the endurance and do half the work which ours do. Captain Maitland, the able Deputy-Superintendent of the Royal Gun Factories, stated at the Civil Engineers' Institute last year, that "the object kept steadily in view by the authorities was to get the highest possible velocity out of a gun with the heaviest possible projectile, or, in other words, to get through the thickest armour-plate at fighting distance, that is at 1,500 yards. But the late Ordnance Select Committee, a very intelligent body of experienced officers, reported that the present guns have "decidedly the lowest velocities." Now, the penetration of a given armour-plate is a matter of the weight of the shot multiplied into the square of the velocity. Perforation is a question therefore of mere calculation. Before going to Portland at all, artillerists could have told that the shot could not possibly have got into that turret. When at Portland I had the opportunity of speaking to some of the ablest artillerists of the sister service, and all that they prophesied concerning the shot, took place; so that we may be assured that their figures are very tolerably correct. Now the velocity of impact required to go through that 14-inch plate and backing, was 1,332 feet; the velocity lost in the 200 yards that the shot had to traverse in passing through the air was 25 feet; therefore the initial velocity required was 1,357 feet. The actual velocity the shot was supposed to have had on leaving the gun was 1,300 feet; there was therefore a deficiency in velocity of 57 feet. Take it in foot-tons: the striking force required by a 12-inch shot to perforate that turret was 7,578 foot-tons; the actual striking force was 6,788 foot-tons; therefore, there was a deficiency of 590 foot-tons. The penetrating figure required to perforate that target was 197; the actual penetrating figure of the 12-inch 25-ton gun was 188 on leaving the gun: there was a deficiency therefore in the penetrating figure of 9. How is it then that our guns have "decidedly the lowest velocities," as is officially reported? The most obvious reason of these "lowest velocities is because they are fired with the lowest charges; instead of having 95 lbs. of P. powder which we know a 12-inch bore can consume very fairly; another 12-inch bore has consumed 120 lbs., and does consume regularly 110 lbs. P.; the "Hotspur's" 25-ton gun only consumed 85 lbs. P. But not only have our guns the lowest charges, they have also the "lowest velocities" when firing the same charges; for that is the condition to which the Ordnance Select Committee referred. I do not think that Mr. Barnaby gave an artillerist's reason for that inaccuracy of fire to which he alluded. I speak in the presence of a good number of very experienced naval gunners, and I think they will agree with me that, as there was an average of half an hour between each shot, and the "Hotspur's" gun was fired by the most skilled marksman in the "Excellent,"—the man who conducts all their experimental firing,—the seventh shot should have been at a distance of 200 yards in such smooth water with only one degree of roll, more accurate than the first, whereas every shot was pretty equally inaccurate. The inaccuracy was very slight. I would not call it "inaccuracy," but "irregularity." Now that irregularity of flight was perfectly well known to every artillerist present at Portland. We discussed its cause and its amount on the way down in the train, and during the progress of the experiment. It is stated in the "Official Blue Books" and "Text Books," and in "Modern Artillery. The reason assigned

for this irregularity of flight is, that the shot does not centre itself in the bore, and is not truly or sufficiently rotated. This explanation is not an invention of my own, but the cause assigned in the official "Blue Books" and publications. The Navy is obliged to take all its knowledge of the 25-ton gun at second-hand from military publications, as its Officers have little or no experience of their own as to this gun or as to the 35-ton gun. How are these "lowest velocities" to be accounted for? The lost velocity is taken up in destroying the projectiles. Only to-day the "Times" has an account of a Palliser shell, which had been fired from a 25-ton gun, having exploded in an immense cupola at Woolwich, whilst being recast with a large quantity of once fired projectiles. What does that recasting mean? Why, that every projectile that leaves a Woolwich gun is so injured in the effort to get out that they are obliged, if it is recovered, to return it to Woolwich, to bore out every stud, and to place it in the furnace, and to recast it. In this ordinary, but most expensive, process, a Palliser shell of the 25-ton gun happened to be loaded, and exploded accidentally. Happily, "Woolwich" shells contain a very small quantity of powder, and the explosion did not do very much harm. If Woolwich guns have "decidedly the lowest velocities" and decidedly the least perforation, there must be other reasons also. It must be remembered that when similar charges of powder are exploded in identical bores with like weights of shot, the same amount of explosive or expulsive force must be developed. If then a short rifle-bearing produces "decidedly the lowest velocities" when compared with a long rifle-bearing in similar guns, what becomes of the missing expulsive force? If that expulsive force is not carried out of the gun by the shot, it must be used up in the bore and communicated to the walls of the gun and projectile. We know that it is used up partly in the destruction of the projectile, and partly in marking and injuring the interior of the gun. There are only three ships which carry these 25-ton guns, the "Monarch," the "Hotspur," and the "Glatton." Not one of these ships is in commission, and when they were in commission, no steps were taken to acquire naval experience as to the endurance of any one of their 25-ton guns when fired continuously and with elevation, for a few hours together. Not one of these 25-ton guns has fired in naval hands a hundred rounds altogether. All our knowledge of them is of a second-hand character, and derived from the study of military publications. I say this publicly, and challenge the authorities to fire 100 consecutive rounds with mis-called battering charges and 2° to 5° elevation from the 25-ton gun. Why, on earth, are these heavy guns treasured up and only allowed to fire diminished charges at low elevations with long intervals between? If they are too fragile to stand proper charges, to be fired with elevation, to go through the continuous and comparatively rapid discharges of a naval bombardment, surely the Navy ought to know it. And the Navy itself ought to try one of them at it, and not trust to second-hand knowledge, which does not include such an ordeal. Here is a special nature of gun which has been afloat three or four years, and yet the Navy does not know by its own experience whether they will stand an ordinary naval battle. I say, that there is no evidence that the 25-ton or 35-ton guns will stand an action at sea, even with the diminished charges to which we are compelled to resort. Ought not the endurance of these guns, which "have decidedly the lowest velocities," to be tested by the Navy? Are seamen gunners incapable of testing a gun? They could be tested at very little expense. Let the "Glatton" be attached to the "Excellent," as was rumoured to have been done last year, as a tender, and take the place of the "Staunch," "Stork," "Royal Sovereign," &c., and let each seaman gunner fire his ordinary five rounds of training practice from one of the "Glatton's" guns. Don't let a single round of training practice be fired at Spithead by the seamen gunners from any other gun for a single year, and before the end of the year, the Inspector of Ordnance will have registered such internal injuries that you will have to re-arm the "Glatton." There is nothing unfair in such a trial. It would be, after all, but a mild ordeal. They could go out to Spithead. The seamen gunners do not fire at Spithead more than some 30 to 50 rounds per week. There would be little extra expense, save perhaps in the matter of coals; but that could be economized, as one or two boilers would do all that is required for target practice. Therefore, I do not think there need be any difficulty on that plea. But surely one of these 25-ton and 35-ton guns ought to be practically tried by naval artillerists.

They ought not to be stored up in tallow and tow until a maritime war breaks out, without the Navy having fairly tested one of them. What harm can happen from such a trial, if these guns are "the most magnificent guns" in creation! the "most powerful guns in the world"! which have "never burst explosively on service"? Where have these heavy "Woolwich" guns ever fired a shot "on service"? I am sorry to have travelled beyond my text, but we cannot discuss the "'Hotspur'-"'Glatton' Experiment" nor the ironclad ship of the future, without giving some consideration to the circumstance that the guns "rifled on the French (or Woolwich) system have decidedly the lowest velocities," and therefore the least perforation and the least endurance.

The CHAIRMAN: I suppose you do not mean that the guns would burst, but that they would become unserviceable in a very short time?

Commander DAWSON: It comes simply to this. As the gun is repeatedly and rapidly fired with heavy charges and elevation, it gets roughened in the wide, deep, empty, upper grooves and lands. The more rough it gets in the inside, the more obstructions occur in the way of the gun-metal studs when going out, and then arises what are called "local injuries." Those local injuries amount in time to the cracking, fissuring, enlarging, and burning, of the interior, and to the disabling of the gun. The injuries may not constitute a permanent disabling, but it will be quite enough to compel British ships to cease firing in the heat of action. If compelled to cease firing, and your speed is not sufficient for running away, the British flag must be struck. The ship will then be towed into an enemy's port. That enemy can then bore out the damages and put in a new steel barrel and a mechanical system of rifling. He can then send that captured gun to fight against British ships, with the certainty that it shall not give way again.

Captain COLOMB, R.N.: I am sure there must be many naval men here who could speak to this question with much greater force and ability than I can. But on Mr. Barnaby's reading his last paper here, I felt it my duty to convey to him personally my thanks for giving us in small compass that information publicly which we could get in no other way; and I wish again to thank him to-night for giving us the salient points of the experiment between the "Hotspur" and the "Glatton," which no amount of reading would put before us in the same small compass, striking our thoughts in the same way. The immediate remedies that he proposes to apply to the defects which were found in the "Glatton's" turret must, I think, commend themselves to every naval officer who has looked even cursorily into the question. Any person who has watched the trials at Shoeburyness, must have always looked with some sort of terror upon the enormous crop of rivet-heads which flew to the rear. And although those rivet-heads, as Mr. Barnaby has said, seldom flew to any distance, yet there was always the doubt how far they would fly, and, it appeared to one looking at the rear of the target, as if the rivet heads formed a sort of projectile which might on occasion be very destructive. Looking at it in the hurried way in which one does on an occasion of this kind, the remedy applied by means of screws seems to be quite perfect: it appears as if there could be no discharge to the rear in the former way. Then the placing of the bolts out of the turret, practically at least, the upper one out of the turret and the other one protected by the glacis plate,—that also saves us from the flying of the bolt-head; and I wish to confirm Mr. Barnaby, having looked at the turret myself after the shot was fired, in saying that there was really no damage visible inside the turret, except that which was done by the flying of the bolt-head. That, I think, would have been very serious to the gun's crew, taking the course that it did. On the general question that Mr. Barnaby brings before us, I must own that he echoes the thoughts that have been in my mind for a considerable time, and, I believe, in a great many naval officers' minds,—we have thought that we have been unduly sacrificing our offensive power for a presumed value of defensive plating, while at the same time our real defence in a turret was, as Mr. Barnaby has distinctly put it, the difficulty of hitting the object. So that practically it was only necessary to protect a turret from an enemy who chose to bring against it a large number of light guns. Your danger was not that the enemy would attack you with a small number of very heavy guns capable of penetrating heavy plating, but that he would bring a large number of moderately light guns, and be able to hit the turret, simply because of the number

of the shot that he fired at it. But if you put a moderate amount of plating on the turret, supposing you adopt the turret system, you guard yourself against such an enemy; and supposing that your enemy brings a small number of heavy guns, your guard then, as Mr. Barnaby has put it, is the smallness of your target. With his general conclusions, as to the future of the guns and armour, I must say I am strongly disposed to concur.

Captain HOSEASON, R.N.: Not being here at the early part of the meeting, I should like to ask Mr. Barnaby one question: is that turret a protected turret, or only just flush? (Mr. BARNABY: A barbette.) A barbette,—nothing more! The question, then, I presume, that you are propounding to us is, "How would you like "to be killed? Would you like the moral probability of being killed in a turret, "or of being drowned?" You propose an armament which many people might suppose would increase the chance of the men at the guns being hit, and you make the ship's side more invulnerable to secure us from the moral probability of being drowned. If that is the way in which you put it, I must say I am from the very first with you; I would rather fight the ship with no chance of being drowned than with the chance of not being struck in the turret. I should take the area of the ship, and, taking the chance of hitting the turret and the chance of hitting the ship, I should come to the conclusion that I was infinitely safer in a ship that would float, without a turret, than in a turret fortified in the manner of our turrets at the present moment. If splinters are knocked about by a ball penetrating the turret, there is no chance of escape. Do I understand your proposition to be that you would add strength to the hull with a view to ensure its not sinking if the ship was struck? (Mr. BARNABY: Certainly.) Your proposition, then, is, "Shall I fortify the hull and make it invulnerable, or shall I bestow "more strength upon the turret and labour to make that invulnerable?" (Mr. BARNABY: Quite so.) Taking that view, I must say I would rather be secure against being drowned.

The CHAIRMAN: Are those intended for turrets in the bow and stern?

Mr. BARNABY: They are barbette turrets. This (pointing to the plan of the deck) is the shape of the turret fixed upon the upper deck. There is an armoured screen round it seven feet deep. There is a turn-table inside for the gun, and a protected means of communication for the ammunition. For the protection of the guns above the turret, you see there is a light framework of iron; on that is a mat-screen over the top and round the sides, dropping down to nearly the top of the fixed part of the turret. That is planted upon the turn-table, and revolves with the gun and slide, so that the gun is always pointing out through the opening in front of this mat protection, which, if it happened to be damaged by a heavy shot, could be pitched overboard.

Captain HOSEASON: You said seven feet was the height of the armour: the battery is open at the top; it is not protected at the top at all.

Mr. BARNABY: Only by the mat.

The CHAIRMAN: What is the height of the guns from the water-line? These are 25-ton guns, I suppose?

Mr. BARNABY: That is a 25-ton gun, and the muzzle of the gun would be about 24 feet out of the water. The drawing represents a ship of 285 feet long, and of a little over 8,000 tons displacement. It is a drawing of a proposed plan; we have nothing of the sort at present. The vessel will have two masts and a bowsprit. The funnels are placed one in the foremost main-deck battery, and the other in the after one.

Captain GOODENOUGH, R.N.: I suppose that one of Mr. Barnaby's objects, in reading the paper, has been to elicit opinions, either *pro* or *con*, to his propositions; and, although I have very little to say and nothing new to offer, I think it is due to him that those opinions should be uttered in this theatre. Therefore, I wish to bear my testimony in entire approval of almost everything Mr. Barnaby has said, and especially of the design which he has put forward; and I must further say, that we are greatly indebted to Mr. Barnaby himself, who, we all know, has been suffering from sickness lately, but who, nevertheless, has given himself the trouble of coming here. We are also greatly indebted to his department and to the Controller of the Navy, for having allowed these drawings to be put before us. I have had the

advantage of being recently in France, and I, therefore, may be in a position to explain to the meeting some of the peculiarities of the French ships which carry these barbette *towers*, as we may prefer to call them, in opposition to *turrets*—upon their decks. The French ships have a battery which, we may say, is more or less like that (*vide* drawing) on the main deck, and the towers which they carry are on the upper deck, on the four angles of the battery, projecting slightly from the ship's side, so that the two foremost guns get a fire almost right ahead and to a considerable angle astern; the two after guns almost right astern and a considerable angle ahead; the rigging of the foremast and mizen-masts being brought down to plates, tied under the main deck beams. There are drawings to be seen of one such arrangement of the battery, in the *Revue Maritime* for last July or August, with a very excellent memoir, by Captain Baron Grivel, who commanded the "Océan." I have met a great number of Officers of the French Navy who have commanded these ships, and, without a single exception, they expressed themselves most entirely satisfied and pleased with the barbette guns. They speak particularly of the very large offensive power that it gave them; that it not only gave them a large arc of fire, but I was very glad to note that they dwelt upon the possibility of seeing the enemy, at the points of your sights the whole way round, even when you had an obstruction in the shape of rigging which prevented firing, instead of having been at one moment hidden from you by the superstructure forward, and the next moment suddenly appearing in sight, through a narrow port, where your eye is almost blinded with light, and where you are not in a position to recognize the presence of an object till it has been for some seconds within your range of view. (The CHAIRMAN: Where you cannot take any sight at all, in fact.) Of course there is a disadvantage in sustaining a close action, at fixed distances, and in a single spot, in a ship with such barbette towers, and I think that this points out the necessity of our having distinct ships for that particular service. That is to say, you engage a battery and you are going to anchor at a fixed distance from that battery, and to engage it for any length of time: it is evident that for such a purpose you must resort to the closest armour-plating you possibly can have, and that you must protect the men who are going to work the guns, otherwise they will very soon be put out of action and your vessel may be obliged to move, or will have to be supplied with fresh men. But where you have a sea-going ship of that description, there is no reason whatever, so far as it seems to me, why you should not discard all that weight of armour which you carry about the gun, for the defence of the crew, and employ it either to increase your speed or to increase your coal-carrying power, or the armour on the belt. In this particular design, there is one other little point which, I think, is a great advantage, and that is, that traverse which crosses the deck, between the two guns, firing right ahead and the two broadside guns. There certainly was a great objection to the port, as it exists in the "Hercules," and, I think, in the "Sultan," that if a shot or shell ever did pass through that angular part, it would probably injure the whole battery of guns, more or less; whereas, with that fitting at present, you have such a distinct defence for the two after-guns.

The CHAIRMAN: Might I ask you, did you inquire what the French did with these barbette guns?

Captain GOODENOUGH: That would take us into a history of the French operations on the German coast. The French ships were so large that, as you know perfectly well, they were not able to approach it. They draw so much water, from their not having attended so much to that point as ourselves, that they are even in a worse position than we are in that respect. The only thing which they did show, was their great capacity for keeping station, and for being always in the right place, so far as they could be, at the right time. The German Admiral, who commanded at the Jahde, told me he admired exceedingly the way in which the French Fleet appeared at daylight in the morning, every ship being exactly in station; and when we come to reflect that that French Fleet was fitted out and sent to sea in about twenty days, and from reserves of seamen and Officers, we may well ask ourselves whether it is in our power to do the same thing; whether we have sufficiently instructed Officers and sufficiently trained men, and a sufficient number of ships in reserve, to send out two powerful Fleets in so short a space of time.

Captain R. A. SCOTT, R.N.: It is impossible to do justice to or to fully discuss an im-

portant paper of this kind, on hearing it for the first time. But if I am permitted to give a paper to the Naval Architects, I shall propose to give my views from a gunnery point entirely, as to the lessons to be gathered from the "'Hotspur'-'Glatton' "Experiment." I will, therefore, pass to the vessel which Mr. Barnaby proposed, in the latter part of his paper, which has so many points of excellence that I am afraid I shall scarcely be able to do it justice. From the cursory glance which the short time admits of one's taking of the design, it would seem that there are a great many points worthy of further consideration, such as the height of the guns out of the water, and other details. But, on the broad scheme, there can be no doubt of its superiority over anything that we have at present. We have, in this design, powerful guns shown at the bow and stern, with regard to which there is a great deficiency in many of our vessels—a deficiency which, I think, ought to be remedied. Not only so, but if one of the protected gun-batteries is disabled, we have, in this plan, other protected gun-batteries with which to continue the action; there are really four separately protected batteries, for, in each, the working portion of the gun is protected by armour-plating. It is, perhaps, hypercritical to say that I should myself prefer one 35-ton gun, instead of two 18-ton guns, on each side of the largest battery, because the power of a 35-ton gun, to penetrate armour at an acute angle, is very much greater, in proportion to weight, than that of an 18-ton gun. And one heavy gun is really better than two lighter guns, because the smoke of the one gun will mask the firing of the second gun; and if you fire two 18-ton guns together, they are still inferior in effect to one 35-ton gun. The weights being the same, in both cases—one 35-ton gun in lieu of two 18-ton guns—would require far less length and would, consequently, enable Mr. Barnaby to shorten his battery, and possibly to make use of the armour thus saved for covering another gun, in some other part of the ship. He has not shown any light guns on the upper deck, but as the supposed advantages of a larger number of light, in lieu of a few of the heavy guns, has been lately dwelt upon, I think it necessary to point out that a larger number of light guns would be really of no advantage, because the smoke from the lighter guns would hinder accurate aim from the heavier guns. The smoke hangs about the vessel firing, and renders it impossible to get off even two or three guns successively without obscuring the view. It is, therefore, a fallacy to imagine that you will ever do greater execution with a number of light guns than with fewer and heavier guns. In respect to hitting accurately, a heavy gun is really more accurate than a light gun, and, therefore, there would be no advantage, in that respect, for the latter, nor can I see any good reason whatever, for going back to mounting, in any of our vessels, a number of guns which are too small to pierce armour. We certainly want, for some purposes, a proportion of light guns; but all our vessels, whether armoured or not, ought to mount plate-piercing guns, so as to be able to engage, instead of running from, the enemy. I believe the preponderance of offensive, rather than of defensive, power will always tell in an action, and that the offensive power, say of one of our largest unarmoured frigates (the "Inconstant"), which would carry five 12-ton guns on each broadside into an action, might decide it. Therefore, I hold that an unarmoured vessel should mount plate-piercing guns, and such a vessel gives the means, as Mr. Barnaby's arguments have so ably shown, of carrying heavier guns than in an armoured one, because, when you dispense with the armour, the ship is able to carry much heavier weights in guns, &c. I believe that this is the direction, viz., of heavier guns, in which we shall have to go. At the present time, as regards heavy guns, I fear that we are really much behind in instructing the hand and eye of our seamen-gunners to use them. I think it is a great mistake to set out with the notion that you cannot get a far higher degree of accuracy than is now obtained. We gunners know perfectly well, as Captain Dawson has truly said, that, in the case of the inaccuracy of the firing at Portland, it was not due to aim, but to the inaccuracy of the flight of the projectile. If you commence instruction with an inaccurate projectile, your men will not succeed in getting any very great amount of accuracy afterwards, from heavy guns. But given an accurate projectile, a keen eye and hand, with proper encouragement to stimulate the skill of the men, then, I believe, they would soon learn to fire at sea nearly as accurately as is now done on Wimbledon Common. I speak from having had great experience in gunnery training, with firing at sea, under all cir-

cumstances, and I, therefore, venture to think that Mr. Barnaby has rather overstated the difficulties of hitting the mark at sea. At first sight, one would say, if such a thing were not done daily, that a man would never be able to shoot a snipe, and yet you know how truly the sportsman's hand and eye go together. A skilled gunner would, in like manner, intuitively feel when his ship was going to roll, and would know how to allow for it. It does not matter whether a ship is down in the hollow or up on the top of the wave, as long as your gun is laid fairly on the mark, for it would only have a slightly different angle, which could be allowed for perfectly. What we should therefore most aim at, at the present time, is to instruct our men more fully, and then, I feel satisfied that we should soon have guns also which would give that accuracy of fire which was not obtained in the "'Hotspur'-'Glatton' Ex-"periment," and which the "'Hotspur'-'Glatton' Experiment" showed there was such a deficiency in. But, as I propose to read a paper specially going into the subject of the erratic flight of the shot then fired, and how, but for that erratic flight, it would have penetrated, I will not dwell further upon the experiment, but only say, there were three causes that prevented the projectiles penetration through the "Glatton's" turret; first, the studs which had to be sheered off; then the erratic flight which caused it to waste its force in making a larger hole than necessary; and, thirdly, its low velocity. If there had been a truer flight, I believe the projectile would have gone through; or, if it had had a higher velocity, even coupled with the erratic flight and the retardation caused by sheering off the studs from the projectile, it would have gone through. Therefore that experiment, as it appears to me, must condemn our present system of artillery, in the minds of all intelligent naval gunners.

Captain FIELD, R.N.: I should like to ask one question with regard to the ship that Mr. Barnaby has submitted to us. Whether he has paid any attention, in the construction of that ship, to the possible action of torpedoes? Whether there is any alteration made in her internal structure to guard against such fearful weapons as I have seen lately? The other day I saw, with wonder and amazement, the action of the Fish Torpedo which, immersed five feet, went 400 yards down a canal, at Woolwich, in a perfectly straight line, and it struck me that the days are coming probably, when, instead of flattering ourselves that we have made our hull perfectly safe, and that there is no fear of our being drowned, we may have to go back to small ships and discard armour altogether, endeavouring, if possible, to guard the bottoms of the ships, instead of merely protecting our engines and our guns.

Commander DAWSON: I should like Mr. Barnaby to explain to us the results of the concussion between the "Northumberland" and "Hercules" the other day.

The CHAIRMAN: I would just put one question myself. The vessel that you have now laid before us carries 25-ton guns, and the guns are 25 feet out of water? (Mr. BARNABY: Nearly that.) Because the vessels that we have had before us, and about which we have been anxious, are vessels such as the "Glatton" and "Hotspur," with a gun down nearly at the water's edge. Perhaps you would have the kindness to explain why, if one set of vessels are supposed to be the right thing with the guns at the water's edge, you are now going up 24 feet? If I am not mistaken, I measured the "Sultan," when I was down the other day at Portsmouth, and her forecastle was 32 feet out of water.

Mr. BARNABY: This drawing of the ship I place before you to-night with the object of illustrating the "barbette-batteries," and not as an official design, because I hoped there would be a little freer answering of the questions which seemed to be rather difficult, and which appear to me to have been avoided. Perhaps those gentlemen who are here will think them over, and in course of time we shall get to know whether we are to go on protecting the guns and gunners, or whether we are really to prevent the ship from being sunk. I have not gone very fully into this design, and I am not at liberty to say anything more about it than I have said. To complete my description I should say, that to protect the engines and the ship herself to a certain extent from the action of torpedoes, this ship is divided by a fore and aft bulkhead, which separates propellers, engines, boilers, and bunkers, and everything connected with propulsion, into two parts, so that there are two independent and complete sets of propelling apparatus. Captain Dawson made a remark which I think was not quite fair: he said that naval architects were left

pretty nearly alone in considering these matters, and that we have not the intelligent criticism of naval officers. I must say (and if any one should know, I should know how that matter stands) that no naval architects could have been better helped than the naval architects of the Admiralty have been by the late Controller of the Navy. (Captain DAWSON: I mean external criticism.) And certainly the novel features in the ships being introduced now, are due quite as much to the present Controller of the Navy as former ones were to the late Controller. If the Controller had not done me the honour of being here to-night to hear my paper, I might say more on this subject.

Admiral HOUSTON STEWART: If there is anything that Mr. Banaby thinks would interest this meeting in connection with that design, I am sure in his official capacity he is quite at liberty to say anything he thinks proper. Perhaps it may simplify matters if I say that that ship has been approved of by the Board of Admiralty.

Mr. BARNABY: This diagram (Plate XIV, fig. 3) shows, as you will observe, the manner in which the side of the "Northumberland" was penetrated by the ram of the "Hercules." You will see that the further passage of one ship into the other was stopped by the armour; that the ram just caught under the under side of the armour. I think the position of the ram has been very well managed, and I think that the defence of the ship has also been very well managed. This space, cut off by the bulkhead which you see here, is so subdivided that although the blow was on a division here, there was only a small compartment that filled with water, and the damage was very speedily repaired, as you know; in fact the ship was as well able to fight immediately after the damage as before.

The CHAIRMAN: I think you will agree that we are very much obliged indeed to Mr. Barnaby for the very interesting and very useful lecture that he has given us, and the many points that he has brought before our notice which are of the greatest importance on these subjects. I hope Mr. Barnaby will before long give us another lecture not only upon the trial of the "Hotspur" and "Glatton," as to their guns and armour, but upon their trials as sea-boats.

TARGET FOR EYE-TRAINING.

By Captain F. H. POORE, R.M.A.

BEFORE I commence to explain this apparatus, I must ask you to allow me to trespass upon your patience for a short time whilst I say a few words upon a subject which has been touched upon by several gentlemen this evening, that is, the necessity which exists that our seamen and gunners should be more carefully trained in firing at objects from rolling ships.

We must not lose sight of the fact, that the sole end and aim of our profession, and at which we are all driving, each in our own particular line, is to keep our service in such a state of efficiency, and so to organise and train the men under our command, as to be capable of inflicting the maximum amount of injury upon the enemies of our country, whenever the time may arrive for us to do so: I think it is generally acknowledged that the gun is our principal weapon for accomplishing that object.

With this end in view, we have been supplied with the most effective guns and the best form of projectiles which the skill of the gunmakers and the experience of artillerymen can produce; they are mounted for

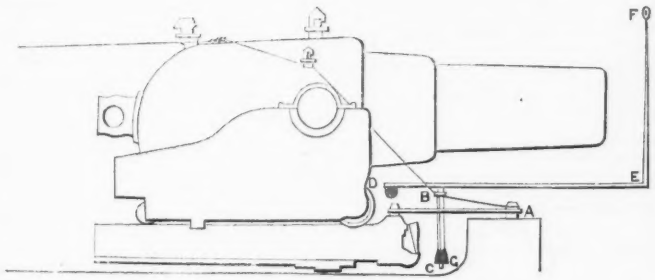
us upon carriages and slides which are models of inventive genius, and much time and labour is spent in training the guns' crews to manœuvre these guns, carriages, and slides with rapidity and precision. All this is done for the sake of placing in the hands of the Captain of the gun the best weapon, and giving him the means of placing that weapon in the best position for delivering his blow upon the enemy. But if, at the critical moment, from any want of practice, the Captain of the gun fails in his most important duty, then the skill and experience of the gunmaker and the artillerymen, the inventive efforts of the carriage-contriver, and the time and money which have been spent upon the training of the guns' crews, are simply thrown into the sea. If we refer to our naval history, we shall find that, in the few cases in which we have failed to gain victories, our failure has been generally attributable to the want of accuracy of the gunners of that period, and men were warned by events to pay more attention to that most important point in their training.

For many reasons the importance of attention to this point of training has vastly increased in the present day. In the first place an iron-clad under steam will roll heavily when a wooden ship under sail will be comparatively steady, and the difficulty of striking the object being so much increased, a more persistent practice is rendered necessary. In the second place, in former days when a ship carried fifty or more guns on a broadside, if one man missed, another would probably hit, and there was every chance of a certain per centage of shot being effective; but now, when some ships carry but two monster guns, it is placed in the power of one man either to do a crushing damage or to throw away a whole broadside.

Seeing then that the captain of the gun has such a heavy responsibility, the necessity of his being most carefully trained forces itself upon us, and it is our duty to consider what means we possess for carrying out that training. At gun-drill in sea-going ships, when there is no object in sight, it is the general practice to warn the men to fire when the sights are brought on with the horizon by the rolling of the ship. But any one who has had any experience knows how impossible it is to get the men to do this, unless an instructor be placed to watch every gun. A man sees no visible result in his being so extra careful, and probably no one knows whether he has made a good shot or a bad one, and, whilst he is conscientiously trying to get his sights on with the horizon, the captain of the gun next to him has fired his shot at the moon, has run his gun in, and half-way out again, and is gaining the credit of being the smarter man of the two. There is an old fashioned plan, which I believe is seldom used now, of running a gun fore and aft the deck, and pointing at the old lever target. I think that apparatus is calculated to do the men more harm than good, as its motion is as much like the apparent motion of a target from a rolling ship as the motion of a Catherine-wheel is like that of a pump-handle, and the men, disregarding altogether the sights on the gun, soon get to know when the corner of the target is coming in line with some part of the ship, when they pull the tube-lanyard and make bulls-eyes with unerring certainty.

The only other means, as far as I am aware, that we possess for training men in firing from a rolling ship, and testing whether they be good or bad shots, is by actual practice from a ship at sea; but this is such a very expensive luxury that it can only be indulged in by a select few.

Having enumerated the various methods of eye-training at present existing in the service, I will proceed to explain this very simple apparatus, and leave you to judge of its value for the purpose for which it is intended.



An iron bar, A B, is shipped on to the pivoting-bolt on the lower port-sill. There is an universal joint at B, from which a rod, B C, hangs perpendicularly between the pivoting-bars. A wooden frame, D E F, is rigidly fixed to B C, so that any motion of B C gives a corresponding motion to D E F, and consequently to the small target at F, which appears in line with the sights above the muzzle of the gun. A weight, G, free to slide up and down the rod B C, is held up by a line, which goes round the trunnion-sight and is attached to the tube-lanyard in such a way that it slips when the tube-lanyard is pulled. The action is as follows:—

The rod B C, and consequently the frame D E F, swing freely with the rolling and pitching of the ship. When the captain of the gun gets his sights on with the target, he pulls the tube-lanyard. The line supporting the weight is let go, the weight falls on to the deck, and being there held by small spikes placed in the bottom of it, stops all motion of B C and D E F, and the target F remains in the same position it was in when the captain of the gun pulled the tube-lanyard, and shows whether he has made a bulls-eye, centre, or outer, or whether he has missed the target altogether.

The apparatus can be trained on the bow, beam, or quarter, and it in no way interferes with the regular drill, except that No. 2, in addition to his other duties, would have to attach the line to the tube-lanyard.

The CHAIRMAN: What size would the target be for an 18-ton gun? and is it outside the port?

Captain POORE: This one I have used with a 7-inch gun. The arm comes through and outside the port, and up in front of the muzzle of the gun.

The CHAIRMAN: Have you tried it with the small ports and the large guns, with the 18 and 25-ton guns?

Captain POORE: I have only tried this with 7-inch guns in a frigate.

The CHAIRMAN: Why I ask the question is, you can hardly see anything out of the port of the turret when the gun is run out, and it would be rather difficult to catch that target.

Commander W. DAWSON, R.N.: In what ship has this target been fitted? and has it been tried in the channel squadron?

Captain POORE: In the "Galatea." One has been sent to the "Minotaur," by order of the Admiralty, but I have heard nothing of it since.

The CHAIRMAN: It appears to me if one of the old guns was run in on deck, pointed fore and aft, and the target stuck in front of it, it would answer admirably. If you stick it outside the muzzle of an 18-ton gun with a small port, there would be some difficulty in catching the object.

Captain POORE: This can be fitted to a gun without interfering at all with the working of the gun: it is capable of being trained in any direction, either on bow, beam, or quarter.

Captain SCOTT, R.N.: An Officer who was present in the "Galatea" informs me that it answered perfectly, and that it has been reported as having done so at the Admiralty.

Commander DAWSON: I must first of all congratulate Captain Poore on the rare opportunity he has had of explaining this admirable invention in the presence of Lord Lauderdale, because no officer has done more to promote eye-training than his Lordship. Lord Lauderdale, when Captain of the "Wellesley," paid great attention to this most essential art of eye-training. I had the honour of serving under your Lordship's gunnery lieutenant and the present Admiral S. W. Jerningham, when he commanded the gunnery ship "Cambridge," at Devonport; and under his talented leadership I had the honour of observing several expedients resorted to by that officer to train the eyes of the seamen gunners by aiming at moving objects both at anchor and under weigh, both in dumb practice and when firing shot; therefore this special subject of eye-training came before me, as an instructing lieutenant, very prominently. I think it is one to which now, in these days, the greatest importance ought to be attached, far more than in the days of smooth-bore guns, because our guns are reduced very greatly in number, and therefore it is even more essential that a larger proportion of the shot fired, should hit the object aimed at. Rifled guns also require far greater delicacy of aim, as their shot do not ricochet straight, and our chances of hitting are limited to direct fire. Fewer eyes directing a broadside demands higher training. Captain Poore's invention supplies a great want, one felt by every gunnery instructor, because of the difficulty we have in dumb practice at sea and in open roadsteads, both in getting any object on which to align the sights, and in observing when the trigger-line is pulled, whether the sights have been truly aligned before the roll carried them out of line with the object. This is essentially a sea target, to be used at all times whenever a gun is cast loose. Provided with such an implement, the instructors could do on board ships at sea with reference to the great guns, that which is invariably done on shore with reference to small arms. With small arms men are never allowed to bring the piece up to the shoulder without aligning the sights upon some object. So in heavy-gun-drill, the trigger-line should never be pulled without an Officer looking over the shoulder of the Captain of the gun to see if the levelling be accurately done. I may remind those who have not had the advantage of seeing the different plans that were formerly in use afloat (which I am sorry to say are not to be found at present at some of our gunnery establishments), that there are a variety of plans which have been employed, and successfully employed, in order to train the gun's crew to follow rapidly the motions of their Captain's hand and eye by aiming at moving objects, and thus training simultaneously the hands and the eyes of the men without using powder and shot. When your lordship commanded the "Wellesley," you will remember that you had a line stretched outside the ship with knots upon it opposite the centres of the ports, and by drawing that line quietly along a few inches at one end of the ship the whole battery of guns were set in motion following with their sights the miniature targets on the rope. Your Lordship had also a means by which the rope

with its knots could be raised and lowered, so that the instructor could vary the elevation as well as the direction. Your Lordship may remember the superiority of the subsequent firing at Kurrachee from the guns of the "Wellesley," showing that your Lordship's care was well rewarded. Your former Gunnery Lieutenant, Admiral Jerningham, when commanding the "Cambridge," invented and introduced a small line target for single ports, by which the seamen could be trained to work their guns and aim their sights without any word of command from the instructor. The line was drawn across the port and raised by pulling its end, and it was drawn back and lowered by the india-rubber accumulator springs. Besides that, Admiral Jerningham introduced the habit of making a boat pass slowly along the broadside, and whilst the battery engaged in independent firing at the water-line of the boat, at varying heights of sight, each captain of a gun had behind him a warranted gunner looking over his shoulder to see whether the sights were correctly aligned to the water-line of the boat. That was one of the most valuable eye-practices we had. A chart of ascertained distances of all the principal objects within sight, including the ships at anchor, was also prepared, and the Captains were required to judge their own distance and lay their guns accordingly, the instructing officer correcting the guess publicly. Whilst inspecting other ships, Admiral Jerningham made his galley or gun-boat pass slowly along their broadsides, according to prepared signals, whilst at general quarters. He also practised the men occasionally at firing with shot at targets towed astern of a gun-boat going at full speed. These practices kept the officers and instructors alive to the fact that the object of gunnery training is not gymnastics, but to strike moving objects with shot. Those plans, and all plans, for training the eye whilst working the gun in dumb exercise, appear to me to be thrown overboard at present: certainly it is so in the "Excellent." I quite agree with Captain Poore in his low estimate of the lever-target. It fails to train the hands of the crew simultaneously with the eye of their Captain. These two objects should be simultaneously effected. No gunnery lieutenant ever paid much attention to the lever-target. They handed it over to the gunner's mate to look after as part of the routine to be got through, but never thought it of sufficient value to occupy their own attention. Then, whilst speaking of the absence of plans for training the eye at dumb exercise both at anchor and at sea, I should like also to point out that the eye is not even trained with accuracy when seamen gunners fire powder and shot from gun-boats at Spithead. No means are taken when thus training future gunnery instructors by showing them how firing should be conducted under weigh, to ascertain the distance of the target or where the shot falls by observations taken at right angles to the range; so that these expensive shot are literally thrown into the sea, and nobody knows what part of the sea they fall into. An obsolete 40-pounder 35 cwt. breech-loader gun is about to be embarked for this inexact kind of uninstructive practice at Spithead—a gun that is not seen in any sea-going ship—and the future instructors of the fleet are to be trained up to this loose way of throwing away shot—men who ought to be taught the most accurate system of aiming and of ascertaining the correctness of their aim, in order that they might be competent to instruct the fleet how to conduct target practice at sea in the most accurate way possible.

The CHAIRMAN: As Captain Dawson has alluded to me, on this question of the artificial way of teaching men to fire, I can only say that I tried almost every possible plan, when I was in the Navy. First, there was the "lever-target," and then we had sights fixed, a musket barrel along the top of the gun, and various other plans. But, I came to the conclusion that there was nothing like real firing, let the shot be ever so small; but it must be powder and shot. The result was this:—I fixed a rifle on a stand, on the poop or in a boat, like a pivot-gun on a centre, one of those proper stands that we have that would not shake. There was a lanyard, the length of a common lanyard to a gun, and I always towed a small target, with a flag astern. The men were put to this, and they were allowed to fire as many shots, with ball cartridge, at it as they liked. The more the ship pitched and rolled, the more difficulty there was. When the men were put to this they, perhaps, would not hit with one shot in twenty, but, in a very short time, firing 40, 50, or 100 rounds a day, the men hardly ever missed the small target with the ship pitching so that you could hardly stand on your feet. That was the result. When I found the men—when the ship was pitching in this way—did not miss one in ten shots, then they were

allowed to go to a gun—a six-pounder—and, having fired the six-pounder put on the poop, in motion, then they were ready to go to a big gun. I am still of the same opinion, that all the practice you can possibly give men, with these large guns, will never teach a man to be a good shot, without some contrivance of the kind I have mentioned. It is given up entirely now, but I think that this plan is very likely to answer, and as Captain Scott has said this target of Captain Poore's has been tried, and found to answer.

Captain FIELD, R.N.: The reputation of the old "Excellent" is very dear to me, and I cannot allow my friend and old messmate here to sit down, and let his remarks go by without a reply. There is no Officer present, belonging to the establishment, to defend the "Excellent," and its system of training. Now, I have the very highest opinion of its system. I know it was a very good one during my period of service there, as an Instructor, many years ago, and I am not so foolish as to believe that it has since, in any way, declined. I believe that, with the present arms of precision, it is not so necessary to waste so much time on "lever-target" practice as was done formerly. Therefore, I think a good deal of the criticism that my friend has passed on the "Excellent," and, also, on her system of firing at Spithead, from gunboats which he finds fault with, is uncalled for. I think if the Officers present would receive those criticisms with a certain amount of misgiving, and would give the Officers of the establishment credit for being thoroughly up to their work, and throwing their whole heart into the work, they would arrive at an accurate conclusion.

Commander DAWSON: Is it a fact that, in training the future gunnery instructors of the fleet how to conduct target practice, by firing from a gunboat, at Spithead, the distance of the target is not ascertained? Is it a fact that, when future seamen gunners, the marksmen of the fleet, are firing shot at Spithead, there is no step taken to ascertain, at right angles to the range, where the shot falls? Is any eye-training adopted, at dumb exercise in the "Excellent," other than the old lever target?

Captain GOODENOUGH, R.N.: I have one suggestion to make. This instrument promises to be very useful. I think it would be found very likely, when the ship is rolling, that, with so long a length of pendulum as there is there, the weight would acquire a certain amount of proper motion, and I would suggest, whether carrying the weight up nearer the point of suspension would not reduce that proper motion, and make the movement of the target more closely resemble the movement of the ship.

Rear-Admiral HOUSTON STEWART: My lord, I can also speak to the small gun you had fitted on the poop, and over which you used to spend many hours every day, teaching and superintending the firing of a whole ship's company. Having been a youngster with you, I subsequently had the pleasure of introducing that same plan into every ship that I have had the honour of commanding since, and it was also introduced generally into the Mediterranean fleet. I believe you will find your own original plan is still adopted and used in many of our ships.

Lieutenant FERRIS, R.N.: I should like to say one word for the "Cambridge." The system of eye-training, on board that ship, is most perfect. Every Friday, at first quarters, a boat passes slowly along each side. There is a gunner at each gun, and the captain to supervise the pointing of the gun, and under Captain Herbert's and Lieutenant Jackson's able supervision, she trains her seamen gunners, in that part of the world, in a most efficient manner.

Captain POORE: I have to thank Captain Goodenough for his suggestion. Perhaps this pendulum, being so long, it does give rather more motion than a ship would actually possess. But I do not think that is altogether a disadvantage, because, when there is very little motion in the ship, it gives the target more motion, and would train the men to fire at a more difficult object.

The CHAIRMAN: You are aware that a pendulum on board a ship, is comparatively useless; it gets a motion beyond that of the ship. In a ship under sail, there is a sort of jerk which sends the pendulum over many degrees more than the heel of the ship. I think you will allow me to thank Captain Poore for his paper. We all know it is a very important point, both on land and sea, to be able to shoot with accuracy. In fact, without accuracy, these monster guns that we have got now, are comparatively useless, for we have so few of them.

Evening Meeting.

Wednesday, March 26th, 1873.

ADMIRAL THE RIGHT HONOURABLE THE EARL OF LAUDERDALE, K.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 4th and 26th March, 1873.

LIFE.

Graham, William, Captain R.N.
Rosebery, Earl of, Dep.-Lieut. of Linlithgow.
Hoskins, A. H., Captain R.N.
Harcourt, E. W., Colonel Cinque Ports Artillery.
Glen, Archd., Lieut., 10th Regiment.
St. John, O. B. C., Captain R.E.
Lansdowne, Marquis of, Under Secretary of State for War.
Foley, Hon. Fitzalan, C. J., Lieut. 2nd Derby Militia.

ANNUAL.

Dugdale, Arthur G., Lieut. R.A.
Browne, H. D., Lieut. 60th Rifles.
Brooshooft, E. A. D., Lt.-Col. 4th East York Art. Volunteers.
Holroyde, J. B., Captain 8th West York Art. Volunteers.
Crossley, Lewis J., Lieut. 8th West York Art. Volunteers.
Evans, H. D., Captain R.A.
Elliott, William, Captain 4th East York Art. Volunteers.
Murray, J. J., Colonel Bengal Staff Corps.
Aytown, Andrew, Lt.-Colonel, h.p., R.A.
Lyttelton, Hon. C. G., Lieut. Worcester Yeo., M.P.
Lightfoot, J.G., Colonel late Bom. Artillery.
Manderson, G. R., Major R.H. Artillery.
Anstruther, Alex. W., Lieut, R.A.
Mackinnon, G. H., C.B., Lt.-General.
Jervis, Hon. J. E. L., Lieut. 7th Hussars.
Spencer, R. H., Lieut. 2nd Dragoon Guards.
Barrow, P. H. S., Lieut. 19th Hussars.
Bomford, S., Major Gloucester Militia.
Crealock, H. Hope, C.B., Colonel Unatt.
Henderson, J. W. Cleland, Captain Madras Staff Corps.
Howell, Thomas, Esq., Director of Contracts, War Office.
Aislabie, R., Major R.A.
Pemberton, R. C. B., Major R.E.
Brownjohn, Wm. W., Lieut. 57th Regiment.
Robertson, R. S., Captain Bengal Staff Corps.
Boyd, A. R. A., Captain 25th Lanark Rifle Volunteers.
Duff, E. Alex., Captain Queen's Own L.I. Militia.
Stewart, Hon. Alexander, Captain R.H. Artillery.
Coventry, H. A. F. F., Lieut. 60th Rifles.
Toole, John, Quartermaster 60th Rifles.
Sewell, John H., sub-Lieut. 20th Hussars.
Hall, Henry. Lieut. 19th Hussars.
Cowan, Phineas, Major 3rd London Rifle Volunteers.
Hale, Robert, Lt.-Colonel 7th Hussars.
Cadell, A. T., Colonel R.H. Artillery.

DISCUSSION on the points raised by Mr. Barnaby, Chief Naval Architect, Admiralty, in the paper read by him, entitled, "Lessons from the

"'Hotspur'-'Glatton' Experiment," and read on Monday evening, March 3rd, 1873.

Points for Discussion.

1st. Is armour retained in ships of war to protect the gunners or to protect the ship?

2nd. If for both purposes, in what proportion should it be distributed? Should the armour in front of the guns be one-fourth thicker than that protecting hull, boilers, and magazines, as it was in the "Captain"?

3rd. Or, remembering that men are of no use in an action without a ship to fight in, but that a ship may remain an efficient engine of war with neither guns nor gunners—remembering this—ought we to keep the hull afloat at all hazards to life and limb from shot and shell"?

4th. If we stint the armour on the hull in order that we may thicken that upon the battery, will not a wise enemy, if he happens to have guns enough, fire broadsides into the hull-armour in order to endeavour to reach the machinery or magazines, and fire, at the same time, with light guns at the gun-ports.

5th. If you decide that the hull must have the preference, and should have thicker armour and surer defence than the guns and gunners, it may be that you would go so far as to say that, in an extreme case, where the weights were strictly limited, you would even leave the guns without armour, in order that the hull may be made secure.

6th. The abandonment of armour protection for the guns leads at once to an increase in the power of the artillery, because the increase in the number of guns, presents but little difficulty as to weights, if they do not require to be armoured. Do you then consider that when we have a ship which has been so armoured as to be practically unsinkable; by shot, in which the boilers and magazines have been made secure, and in which the number and power of the guns have been so increased, that a concentrated broadside may mean six or seven 18-ton guns—all directed at the same spot, and fired by wire at the same moment—do you consider that such a ship would stand a fair chance in fighting with an enemy with penetrable hull-plating and few guns, but those guns protected by armour?

7th. If you think she would, let me add, an armoured traverse at each end of the gun-deck, with ports in it for right ahead and right astern fire, and let me add also an upper deck armament of light guns to fire at the ports of the enemy, and she will probably commend herself still more to your judgment.

CHAIRMAN: Gentlemen, before we begin the discussion, I think it right to say that we are here to-night solely for the purpose of discussing the points that Mr. Barnaby put before us at our last meeting. I hope, therefore, that all the speakers will keep to these points, and not fly off upon gunnery questions, otherwise we shall not get through the business of the evening.

Mr. BARNABY: My Lord, Ladies, and Gentlemen, in accepting the invitation to come here to-night for a discussion of the points which I laid before you the other evening, I said that I should like to say a few words before the discussion opened. I think these few words are due to those who heard my paper, because I have been

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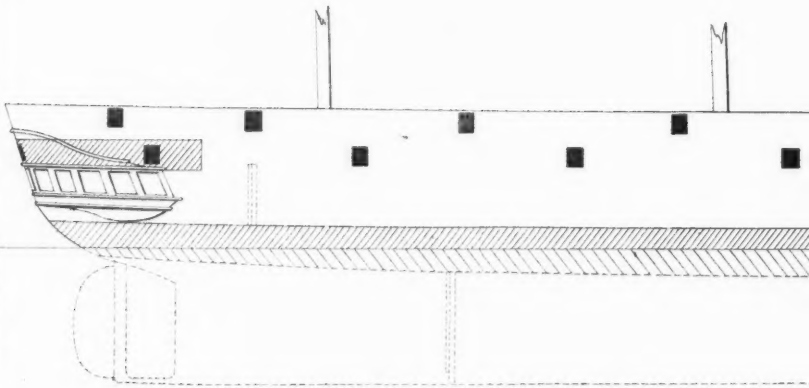

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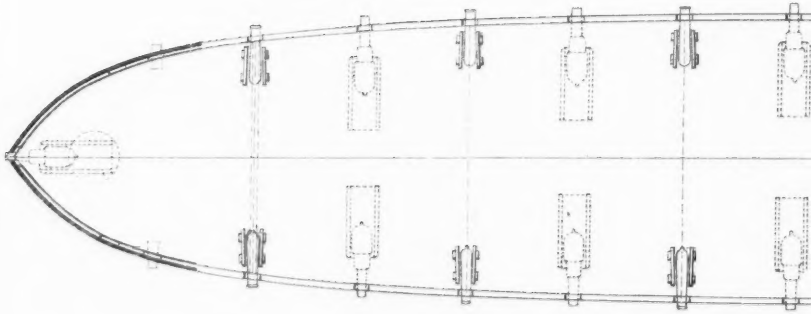

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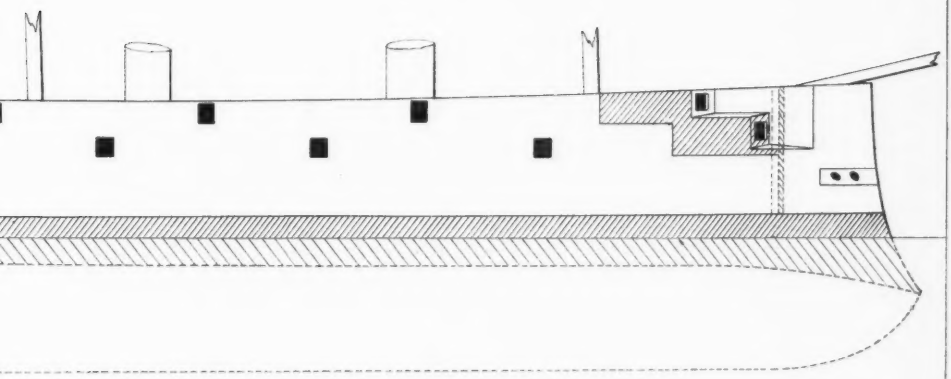

UPPER AND MAIN DECKS.

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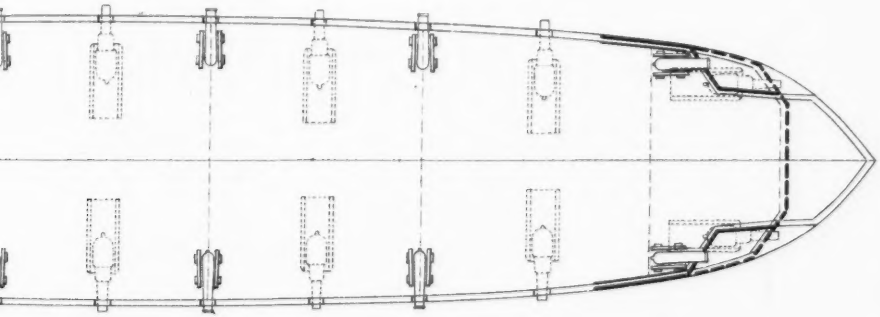


e shaded parts represent Armour

J. Jobbins

told that I did not make it clear that the drawing of the ship then shown, did not represent the ship which is pointed to in the questions referred to this Institution for discussion. I did not then state anything more about the ship than this, that she illustrated the "barbette-battery." I may say now that those two drawings represented the "Téméraire," *see* Plate XV, which is to be built at Chatham. She is, as will be seen, and as I pointed out when I described her before, different from any ship which has been built in England up to this time in respect to these upper deck batteries, and if you will allow me I will just make clear what the ship "Téméraire" really is. She is then a ship of 14 knots speed. She has 11-inch armour for the protection of the hull, and 2-inch plating on the deck. She has two batteries on her main deck, one lying immediately before the other. Those batteries are so arranged that the guns in the foremost one, which are 25-ton guns, proposed for the first time to be broadside guns, fire right ahead. This battery abaft, cut off from it by a traverse of armour, contains four 18-ton guns, which do not fire either ahead or astern. She therefore has a main deck battery of three guns on a broadside, one being of 25 tons and two of 18-tons. On the upper deck, instead of there being a central battery, as in the "Sultan" the "Swiftsure," the "Triumph," and other ships, these two armoured "barbette-batteries" are introduced, one containing a 25-ton and the other an 18-ton gun. The foremost one answers the purpose of a conning house as well as a battery; it is protected by 10 inches of armour; the after one, by 8 inches of armour. The ship thus has three 25-ton guns ahead, one 18-ton gun astern, firing all round the stern, intercepted only by the rigging of the mainmast; the foremost one firing all round the bow, intercepted only by the rigging of the foremast, and she will have a broadside of two 25-ton guns and three 18-ton guns. The main battery is protected by 8 inches of armour all round, and the inner traverse has 4 inches of armour; this after battery is therefore protected by 12 inches of armour.

This ship (Plate XVI) may be regarded as a sort of compromise. She has more powerful fire than she would have had if some armour for the defence of the guns had not been surrendered. Some armour for the defence of the guns has been given up; the guns fight on the upper deck in the open. The question to-night is, as you will see from the paper, "to what extent should armour be retained for the protection of guns"? The ship which is intended to illustrate the questions put by me the last time I was here, is shown by these diagrams. This is a ship of the same size as the "Téméraire," but she has what may be called an open battery. The hull of the ship is protected in the same way in both ships, but there is no armour for the protection of the guns except at the bow and stern. There is a traverse of armour across the bow behind which those two guns fight, and which protects from a raking fire, the whole battery. There is a traverse of armour also across the stern, protecting one gun, and protecting from a raking fire, the stern of the battery. The battery therefore would consist of seven broadside 18-ton guns for concentrated fire, and a battery of twelve light guns on the upper deck, 64-pounders. That is the ship which is indicated there.

There are several forms which the "open-battery" ship may take. You may have a ship with the same protection to the hull, as in this case, but with 300 or 400 tons of armour removed from the ship as compared with the ship with all her guns protected by armour, and that 330 tons thrown into guns and ammunition. Another way in which the question may be viewed is, that, supposing the guns are not protected, the hull-armour may be by so much increased. For example, there are existing ships in which we have about 700 tons of armour to protect the hull, and 1,200 tons of armour to protect the guns. That is another way in which the question may be put. I am just mentioning these things in order to direct as far as I can the discussion on the seven questions.

It is necessary that I should say another word as to the history of this design. That design was discussed when consideration was given to the designs for the "Téméraire." It is an abandoned design, which was discussed in the autumn of last year. The reason I mention it is that, curiously enough, at the very moment that we were discussing the plan, they were discussing in France, the very same thing without our knowing it. I have here a brief extract from a very interesting article which has been published in the February number of the "Revue Maritime," by Vice-Admiral Touchat, who occupies a position in France corresponding to that of the Controller of the Navy here, and with your permission I will read a few

extracts from that, freely translated, and with certain omissions. Referring to the "Gloire," "Marengo," "Hercules," and "Kœnig Wilhelm," he says:—"These, "then, are the instruments for fleet-fighting of to-day. Is it to be believed that "they will continue to occupy the first position, that they will be the *ne plus ultra?* "No, for the gun goes on always increasing in power; and in France, as in England, "Russia, and Prussia, we are no longer contented with guns of 10 and 11 inches, "we go up to 12 and 13 inches, and there are laid down in the dockyards, ships for "fleet-fighting, plated with armour from 9½ to 12 inches thick, and from 9,000 to "10,000 tons displacement. Where shall we stop in this strife? Where will it "end? I see the end" (he goes on to say) "in the abandonment of armour for the "guns. Sooner or later this will be the end for the "navire d'escadre," or, as we should call it, the armoured cruising ship. "Let us admit if you will," he says, "that the battery should for the future be plated with armour of 10 inches, as it "soon will be, the question of abandoning it will nevertheless be resumed upon these "two considerations:—1. Is battery armour of 10 inches penetrable? 2. If it is "penetrable, does it not become rather a danger than a protection?" And then he goes on to say:—"And now let us see what will take place in a battle between fleets. "The two squadrons being in order of battle, if both freely accept the contest, there "will be collision by ramming, either with or without preliminaries. In any case "it will suffice that one of the two should be resolved for it to make ramming the "first act; let us mark the opening phase of the fight. The combatants advancing "towards each other would be ranged in one line, or in several, or in squadrons; "but, whatever be the order of battle, there will be formidable collisions and grind-"ing of the sides; they will cross each other's course, and then, putting the tiller "hard over, will return to the encounter. Again will they strike and again pass on. "Woe to the vessel which, disabled by the first attack, or turning less quickly than "her adversary, exposes her flank! Like the 'Ré d'Italia' at Lissa, she will be "sunk by a single blow.

"It is here—in this initial phase—the ships perpetually fouling each other, that "the gun appears on the scene in all its might. The manœuvre is foreseen. A "single order, clear, concise, energetic, follows in three words, 'prepare for ram-"'ming.' At this command, the guns are pointed low; the captain of each, his eye "fixed on the sights, with bent body and extended arm, waits! He watches the "moment when his adversary will pass before the muzzle of his gun—the moment, "fleeting as the light which he must size for firing. Silent and motionless each "man is at his post, but lying full length upon the deck. The Captain alone remains "erect; suddenly the guns and musketry burst forth, and the vessels crash into each "other with their sharp-pointed prows, and gliding by each other prolong the con-"tact along their sides until they reach their sterns, which they avoid in order to "protect their rudders and screws. After this first encounter, the combat will always "be carried on at a short distance, if not broadside to broadside, the gun and "rapidity of evolution playing the principal *rôle*.

"In this strife of vessels, let us take two opponents. The first is an armour-"plated cruiser, with 9½ plates on the battery, which will soon relegate the actual "vessel to the second rank;"—9½-inch plates on the battery is the thickness which "has actually been adopted for the most recent design of the French Government;—"it is armed with 12" or 12½" guns, carried in two divisions, *i.e.*, two or three on "each side. This is a small quantity, but the more the weight and calibre are "increased the more the number is diminished; thus it is that the 120 guns of "our old three-deckers are represented—I might almost say combined—in the "armour-clad cruiser by 8 or 10 guns. Now with regard to the military value of a "gun, its efficacy does not wholly consist in the size of its bore; of what importance "is a large shot if it does not attain its destination? In the vessel of 120 guns the "loss of a single badly-directed shot is comparatively nothing; in armour-plated "ships the loss of a single shot of the eight or ten which I can fire is a great deal. "For each of these great guns ample fighting-room is necessary in order that it "may be freely and rapidly manœuvred; above all, it is necessary that the gunner "—the soul of the gun—in the midst of these evolutions, these tournaments of war-"fare, should always see the object of his aim, always follow it with his eye, to strike

" it at the favourable moment. Is this possible through the narrow frame of a port-
" hole full of smoke and quite filled by the muzzle of the gun?

" But this is not all. This central fort, with its side armoured with plates
" 9½" thick, is not impenetrable in all the phases of this fight, and at all the
" distances. It can be pierced by the enemy's shot, and without doubt such will
" be the case. Imagine what effect will be produced by one of these projectiles
" penetrating the central fort, there bursting and projecting before it a murderous
" cone of fragments of wood and iron. The space is confined, the guns are disposed
" in two lines, starboard and port; the men are crowded. Everything will be cut
" down, overthrown, destroyed, not a man will remain erect, not a gun in a fit state
" for firing. 'All will be over,' was said to me by one of our officers, who during
" the war commanded one of our most powerful armour-clads.

" Of what service, then, is this cuirass from the moment when it is penetrable.
" Far from being a protection, it is a danger, and it only interferes with the fire of
" those guns which it is powerless to protect.

" Of the two adversaries whom I have considered the second is unarmoured."
Admiral Touchat's view, in what follows, is not at all the view I have taken. " It
" has the same number of guns as the first and of the same calibre, but, instead of
" being concentrated in two lines in a battery, these guns are disposed '*en barbette*,'
" on a carriage with a central pivot, occupying a single line amidships in the fore-
" and-aft plane of the ship," an impracticable arrangement, as I venture to think.
" There they are, in the open, in full sight, commanding the whole horizon. The
" advantages of this arrangement, viewed with regard to efficiency, are very striking.
" In lieu of the training space, limited and almost annulled by the narrowness of
" the ports and the size of the guns, there is substituted for each piece a training
" space extending from side to side, while the glance of the gunner in full possession
" of the horizon, ranges freely and uninterruptedly over the object to be attacked.
" There is another view in that inevitable phase of the combat in squadron which
" for an instant—and that a decisive one—places the combatants side by side, she
" brings the whole of her pieces into play, whilst the ship with a battery can only
" oppose a half. Thus it is that, to the broadside of three guns from the battery,
" the ship without it can oppose six guns of the same calibre.

" Thus in the double light of the number and proper direction of the shot, of
" their efficiency, the advantage belongs to the second vessel, to that whose artillery
" is not cuirassed. But this is not all. By suppressing the plated battery a great
" economy of weight is accomplished, and this economy if entirely applied to dis-
" placement permits a diminution in the length of the vessel, to the great profit of
" its powers of evolution, so that, other things being equal—that is, with the same
" speed, the same handiness in manœuvring, the same sail power and armament—
" the one ship will turn quicker in a smaller circle; now, to turn quickly in a small
" circle is the *cardinal* faculty in an engagement with prows.

" Thus, in conclusion, the vessel without an armoured battery will cost less, be
" more handy, more capable of evolution, and its offensive power, considered with
" respect both to the gun and the prow, will be notably increased.

" I stop here. After having put two adverse squadrons face to face. I have
" detached two vessels from the group of combatants, both equally protected at the
" water-line, both armed with guns of the same calibre and equal in number. In
" the one case these guns are covered—I can no longer say protected—by an
" armoured wall; in the other they are exposed, or merely masked by a movable
" screen of steel plates which protects the gunners from musketry. These ships I
" have opposed to each other, and by bringing before the eyes of the reader succes-
" sive phases of the combat, I have endeavoured to show that the advantage should
" belong to that whose guns are unprotected, it being thoroughly understood that
" I only speak of *lateral* protection. The principle of a combat 'end-on'—that is
" to say, by ramming—being admitted as a consequence of the spur, and as the base
" of naval tactics, the *longitudinal* protection deduces itself; this is obtained by
" means of an armour-plated transverse bulkhead placed forward, or by some other
" analogous disposition. As it is not my object to define the means, I confine
" myself to simple indication."

" It should thoroughly be borne in view that I have taken care to define the

"nature of this inquiry; I repeat it is only a question with regard to cruisers as to "the amount of protection and of the artillery they may carry. Were it a question "of coast defence vessels it would be quite another thing. The coast defence ship "may pretend to invulnerability (long though the word is, it may well be employed "to express the thing)—it can pretend to it especially on account of its form. The "cruising ship cannot pretend to it; at the most it will only obtain a *relative* "invulnerability, that is to say, dependent on the distance of the combatants and "the direction of the shots. But in a fight between cruisers, as I understand it, "the distance will in no case exceed what I have termed '*fighting distance*,' from "1,000 to 1,300 yards, and in that initial phase, which I have called the *decisive* "phase, the greater part of the blows will strike square to the surface. If, then, "anyone claims for the cruiser relative invulnerability, I may be allowed to refuse "him the benefit of it."

"If it be true, on the other side, that as against the cruiser as it at present exists, "either afloat or building, the gun has definitely asserted its superiority, there are "only two possible solutions of the fighting ship, the mastless ironclad, such as "the 'Devastation,' or the Russian monitor, 'Peter the Great,' and ships masted "but without protection for the artillery. These two types combined—armoured "ships without masts, masted ships without armour, mutually aiding and assisting "each other will form probably the fleets of the future, but that which from the "present time can no longer be doubtful, is that the masted armour plated ship of "war, will no longer figure there."

As a comment before sitting down on that paper, which has just appeared, I may say that it is understood that the newest design of the French Government produced under this gentleman's auspices, has eight armour-piercing guns only,—she is the same size as the "Superb," viz., of 9,000 tons displacement. Four of those guns are left to fight in the open without armour. For the protection of the other four, the weight of armour taken would increase the weight of the armour required for the protection of the hull by 50 per cent. For the protection of four guns out of the eight, half the entire weight of hull protection has been taken, and the thickness of the armour protecting those guns from right ahead fire, is equal to the thickness of the armour for the protection of the hull. It is clear, therefore, that Admiral Touchard has no more been able to get rid of the armour in front of his guns than we have. Having placed the questions before you, I will now leave them to be discussed.

Rear-Admiral Sir JOHN HAY, Bart., M.P.: My Lord, Mr. Barnaby, and Gentlemen, I have come here this evening to obtain, as I always do when I come to this Institution, valuable information concerning the profession to which I formerly belonged; and I have come here to-night more especially because there is a discussion about to take place in the House of Commons on this very point. No doubt the matter before the House of Commons with regard to the ship that is about to be built,—I think the Controller is here,—has been delayed, not in consequence of this discussion, but because Mr. Goschen, the First Lord of the Admiralty, in the kindest manner, has sought for thorough information before he decides upon the class of ship which he is about to recommend that the country should build. I wish to give him every credit for the course he has taken. As Mr. Barnaby has well stated, ship-building now must be a compromise. There must be certain things given up, or portions of certain things given up, in order to obtain other things, or portions of other things, which are necessary for the conduct of our men of war.

The questions that have been propounded to-night, I shall endeavour not to reply to distinctly, but having a Scotchman in the chair and being a Scotchman myself, I shall take the liberty of replying by sundry other questions with a view of eliciting further information, not only from the accomplished lecturer, but from the other accomplished ship-builders and naval officers who are present, and who are far more competent than I am, to speak upon this question. There are, as we know, very few ship-builders and very few naval officers in the House of Commons, and it is right that those who go there and speak upon a question of this sort should do so not in any party spirit, but with a view of getting the very best ship for the country, and when the Controller of the Navy, and the President of the Board are so kind as to invite discussion, and to ask for the best information on those points on which

we may agree or disagree with them, I think we ought to support them on just and fair grounds, not political, but of naval architecture and reason.

The seven questions before us all bear upon one point. I do not intend to traverse the ruling of our chairman; I am not going into any gun question or any question irrelevant to the seven questions which have been fairly propounded, and which are fair and proper objects for discussion. But I think there is a point which we ought all to recognise, and that is, first of all, what sort of ship do we want, as a man-of-war, be she large or small? What are the principal points we require, whether we be naval architects to build ships, naval officers to command ships, or tax-payers to pay for the ships, or the country to be defended, what is it we require for the class of vessels to carry the guns, and the seamen to fight our batteries?

The first qualification for a sea-going man-of-war is that she shall be seaworthy, and able to keep the sea. I think those are the first two points which we must admit to be necessary in all ships. Leaving entirely out of question any ship like the "Glatton," I am going to discuss a ship which shall have masts, and which, according to my view, having masts, will be a sea-going man-of-war, and I will confine myself to that. She shall be seaworthy, and able to keep the sea. What is seaworthiness? That is a point upon which I do not think we shall differ. Seaworthiness consists of adequate proportions, a just distribution of weights, and sound workmanship and material. The two first points are those points in which compromise is necessary—the question as to the adequate proportions and the just distribution of the weights. I do not go into the question of sound workmanship and material, because that is of course necessary. What does keeping the sea require? It requires a sufficient and healthy accommodation for the crew, sufficient space, and I wish to note this adjective—I do not know whether it is a right one—sufficient space and inexhaustible means for conducting the ship in safety on her various duties. I put that "inexhaustible," because coal is exhaustible; I am therefore putting it with sail power, and sufficient space for the armament and its exercise. I think that gives what a ship which must continually keep the sea requires, having already stated that she is to be seaworthy, and not to be dependent upon a coal tender, but to be capable of maintaining her position in all weathers, at all times, and under all circumstances.

The next quality, I think, a man-of-war requires is speed, and as the supreme effort will usually be made under steam, that is to say, when she is going to fight, or going into action, or when she is chasing, steam will be called into play, speed under steam should rather have the preference in her form. I do not say whether I prefer the screw, the paddle, or the hydraulic propeller; I am not going into that question at all, only the vessel should sail well and steer well under sail. But if to obtain a great speed under steam the sacrifice of a little speed under sail is necessary, I think it should be done, for the supreme effort to be made is when having saved her coal by her sailing power, it becomes necessary for her to fight her battle or chase her enemy; then her greatest power is called out, and her greatest speed will be under steam.

There are two or three other things which are partly in the nature of compromise, but are very valuable in men-of-war, and one of these is "light-draught," so as to be able to go in and out of harbours in all parts of the world at all times. There is the well known and constant Suez Canal, which of course gives England additional power in her Eastern and Western possessions. There is the St. Lawrence, and there are a number of other places where light draught is of the greatest possible value, and where men-of-war may be required. Putting first the seaworthiness, ability to keep the sea, and speed, I then come to light draught. I suppose it is useless to clothe such a ship as that. No doubt, barring light-draught, you might get a seaworthy ship, a ship to keep the sea, and a ship of great speed, entirely clothed with impenetrable armour. If the rule which did obtain, holds good, that a ship of a thousand tons will carry an inch of armour, and, roughly, that for each additional inch of armour you require a thousand tons, when you come to the 16 inches which is now required to protect us against some of our guns, you naturally would require a ship of 16,000 tons before you arrive at a ship completely protected. Therefore I come to the conclusion at which Admiral Touchard has arrived, that it is impossible to conceive of any ship but a ship of the very first class, ships of which I do not think

many are likely to be constructed, which will be entirely and completely covered with impenetrable armour. If the armour is not impenetrable, then it is worse than useless. I had the honour,—as I dare say many distinguished Officers here present had,—of knowing an Officer whom all naval Officers must regret, I mean the late Admiral Tegethoff, one of the most distinguished Officers who ever commanded a fleet. Admiral Tegethoff, relating to me the events of the battle of Lissa, spoke of the "Affondatore," and defended his antagonist, who, unfortunately for him, Admiral Persano, had hoisted his flag therein. Admiral Tegethoff pointed out that he himself, having his flag in a ship very partially protected, and not at all protected in the upper works, had the singular advantage of having a ship which was so handy that she rammed and destroyed the "Palestro" and the "Ré d'Italia," and that in doing so he lost very few men; whereas the "Affondatore," being totally unmanageable, was unable to do any of the service which no doubt her Admiral desired she should do. She was invulnerable no doubt, but she was helpless from being overweighted; and Admiral Tegethoff pointed out that in some of the ships of his squadron, which were partially armoured, the shell were just detained long enough in passing through the armour, to burst where they were wanted to burst, whereas in the ships which were not armoured, they went right through, and burst a long way off, where they did no damage. We are now coming to shell, which, unfortunately, may be detained a very short time and will do an enormous amount of destruction should they burst, if they are detained long enough to burst in passing through a ship.

But we have also to guard against the ram and the torpedo—the manageable torpedo. We have information of torpedos that are manageable no doubt, used in the American war, but they have been recently only re-invented in a manner which can be applicable to sea-going ships in deep water. We have now the ram and torpedo to defend ourselves against, and I confess I believe the wound from a ram or a torpedo will be far more serious than the wound from any shot or shell. If that be so, what part of the ship is it best to protect? Where will the wounds be inflicted that are most dangerous—not the wounds alone from shot or shell, but the wounds which will also be inflicted by the ram or torpedo? If one considers that, I think it would be admitted that the great danger is not the danger of having your men killed, nor is it the great danger of having that which was considered also, having your men demoralized by very great slaughter in the batteries. The slaughter in the batteries will be nothing to the danger of being sunk or blown up. I conceive therefore the first thing to protect is, the magazine. I do not speak externally. I mean to say that the magazine in these days should be entirely, and perfectly, and thoroughly protected, so that there should be, as far as possible, no danger from any external missile. Next to that, as I have already said, in this masted ship, the ship which is able to keep the sea, but which requires that her machinery shall be available for taking her into action, the next thing is, as far as possible, to protect that portion of the engine-room in which that motive power is contained.

After that, and many persons would put it first, and I am not quite sure whether I should not put it first myself, but I put it third, is the "steering-apparatus." I put it third, because the rudder is so difficult to protect in itself, that the rest of the steering apparatus, the rudder being destroyed, is of no use, and therefore I would not devote so much to protecting the wheel and tiller as I would to protecting the magazine and machinery. And I say that, too, with the hankering desire which I admit, after the hydraulic propeller. But I won't go into that now. I merely say that, because I think by means of a hydraulic propeller you are able to steer the ship even if the rudder is damaged. That is a controverted point, but I allude to it, and I say that the steering apparatus, perhaps, should go first, were it not that I have in my inner consciousness a belief that there is a power, which Mr. Dudgeon and others possess, which might assist us in protecting the steering apparatus.

After that I come to the machinery of the gun. I am not going to discuss the turntable, or going into any other question, but all our heavy guns require very delicate machinery—I mean delicate in this sense, that they are liable to destruction by shot and shell. As far as the lower portion of the gun-carriage can be protected, I think it should be protected. I have not yet convinced myself whether the

barbette tower system is the best, but I do confess, to maintaining the magazine, the steering apparatus, and the engine-room of the ship thoroughly, as I ventured to suggest; after that the fighting portion of the ship, that is to say, the means of training the gun and working the gun, leaving the gun and its men to take care of themselves; but that is the next thing to which you should devote complete protection. In all these points I may speak of the application,—as far as may be possible,—of very thick armour, as thick as the ship can carry, for the particular purpose of protecting the portions in detail which I have mentioned (in the small ship in which you cannot afford a fraction of armour to protect anything but the magazine, I would have the magazine thoroughly protected): each protected by itself, entirely and completely, in the order in which I have ventured to suggest.

Well after that comes the water-line,—I mean that portion of the ship which is likely to be injured by the ram or by the floating torpedo—that portion of the ship in which she may be hulled between wind and water by shot or shell—it would depend in certain ships as to whether it was a band of 4 feet, 6 feet, or whatever it might be, but it would be in proportion to the distance the ship was likely to roll and was likely to expose her side in action, and also to what was likely to be effected by the various considerations that I have ventured to allude to. There I would give the next protection.

After that I would try to protect the men, though I do not think there would be anything left to protect them with; and after that in the 16,000 ton ship, when Mr. Barnaby is so kind as to build her, and Parliament votes the money for it, then I would protect the whole ship and not till then. Now I have ventured to state as shortly as possible my questions in reply to the seven questions, and I hope I have not gone beyond the limits of fair discussion, and that I have endeavoured to put forward my views in no arbitrary manner. They are the views, that, unless I am better informed by the discussion of to-night, I should have expressed if these questions were put to me in the House of Commons, and, I have come here because I wish to find out where I am wrong and to be corrected. I am not at all sure that I have put forward views which will be acceded to by my brother officers or by shipbuilders present; but I thought it was not fair when so excellent an opportunity was afforded me, for gathering so much information, to allow it to pass. I only desire in conclusion to thank Mr. Barnaby for raising this discussion, and you, my Lord, for taking the chair on this occasion.

The CHAIRMAN: Before you sit down, Sir John, I think we are to understand from you that with regard to the first question put, "Is armour retained in ships of war to protect the gunners, or to protect the ship?" that your principle is first to keep the ship afloat, and, afterwards, to protect the guns as well as you can?

Sir JOHN HAY: That is the purport of my observations.

Mr. JOHN DUDGEON: As Sir John Hay has kindly named me in the course of his remarks, I feel bound to say something on this subject, and as Sir John has said that your Lordship and he were Scotchmen, and I also am a Scotchman, I may not, perhaps, be taking too much on myself. I do not speak on this subject as holding the same views or with the same sense very likely as the man who has to fight the vessel; or the designer of the vessel. My impression is that we are very much inclined to over-estimate the difficulties in this matter—that we are very much inclined to imagine that a difficulty exists when it does not really exist. Taking the guidance of my friend, Mr. Barnaby, he being a constructor, and I only a builder, and taking the opinions of my friend, Sir John Hay, as those of man who is going to fight the vessel, I must say I really do not see where any of these difficulties are. If I were asked to build a vessel to carry so many tons of weight in the shape of armour, so many tons weight in the shape of guns, &c., and I were asked to put that material in such a position as to be of the greatest possible advantage, I as a constructor would say—I would give him as much as he could possibly have—and I cannot conceive or I cannot understand for one moment why any difficulty should be raised when there really is none existing. What we have to do is this. We have to move heavy weights, such as our modern guns are, and we have to turn them round very quickly. Any man who has passed through the ordeal of partridge shooting knows perfectly well that there is only one method, namely that of making a pivot of yourself, and no matter whether he is shooting a

partridge or whether he is going to shoot a big ship, he has simply to do the same thing. The process is precisely the same in both cases. There is no other process that can be devised by Mr. Barnaby, by myself, or by any other man who is engaged in the gigantic business of ship-building, save that of placing your gun on a turntable and the only turntable that you can have, is that of the ordinary "Monitor." There is no method by which you can make a broad-side ship by any means that you can possibly devise, where you can get the same weight of ordnance as you can get in the ordinary monitor, such as those Mr. Barnaby has designed. As a constructor I must take leave to be at issue with what I gather to be the general opinion, namely, that it will be possible to build a ship in which men will fight as well without being protected by armour-plating, as they will do when they are protected by armour-plating. No matter what thickness the armour-plating may be, if I am fighting behind armour-plating, then I feel a sense of protection. With reference to the remark about the shells coming through, I must say I have great doubts about that, and I believe that the whole position assumed with regarad to *not* protecting the guns is entirely wrong. I believe that there must be a compromise between the two, and that is this: We will give the best bottom to a monitor, that possibly can be given, and I am equally sure that we can carry all the canvas that might be required to enable her to be a sailing cruiser, and that we can give her all the steam-power that may be required to make her the fastest ship on the sea. I do not think that there are any really practicable difficulties in the way. I am perfectly sure that our friend, Mr. Barnaby, could turn out something to meet those requirements, but I can assure him of one thing which neither he nor any one living will ever do and that is—turn out an unprotected ship to fight a protected one.

Mr. BAILLIE: With regard to the protection of the guns and gunners, which is a very important matter, and one of the questions raised by Sir John Hay, I would ask whether that could not be obtained by applying the Moncrieff system? It seems to me that if you were to work the gun on the hydro-pneumatic system, you would certainly gain complete protection to your guns and also to your men, because they would be down below. I would ask also, whether a better distribution of weights might not be obtained by that system? Because that is also an important question.

CHAIRMAN: I suppose you mean, if the guns were mounted upon Major Moncrieff's system the same armour that protected the ship afloat would also protect the gun when it was lowered down.

Mr. BAILLIE: Certainly, my Lord. And also with regard to the distribution of weights. As a sea-going cruiser, she would carry her guns, which are important weights, lower and better than she would if she always had them on the top of the upper deck or in a turret.

Captain COLOMB, R.N.: There are some points to which I did not address myself on the last occasion, and which I should like to mention now. When Mr. Barnaby read his paper, I expressed a general and strong concurrence with his main views, and I must repeat that concurrence now, but on reading over more closely the questions that he puts to us, I am not quite sure that I agree with him in all the details. But, sir, there is one thought which always comes to my mind during the discussions which I listen to in this theatre on the questions of "armour versus guns," and of the general method of building the war ship of the future, and that is, what an immense quantity of opinion we hear expressed, and how very little fact is adduced to back that opinion. I gather one lesson from all the discussions, and that is—we want experiment, and I am perfectly satisfied that until we will consent to spend money, time, and trouble on experiment, we shall never get to the bottom of the question we are discussing to-night.

CHAIRMAN: Do you allude to Government or to private individuals?

Captain COLOMB: I allude to the general fact, that it is impossible to decide a question of this kind on opinion; that you must have more experiment before you can decide what is right and what is wrong. I have been greatly struck with the translation of the paper by Admiral Touchard which the lecturer has read to us. I had read previous papers of his, but up to the present time I had not seen that particular paper, read to-night. There, I think, we saw expressed in the strongest way the want of fact and the bold expression of opinion which we see universally in

the discussion of these questions. I found great difficulty in drawing any lesson whatever from Admiral Touchard's remarks. I found him describing a ship going to ram, with, so far as I could make out, her guns manned, with a clear intention of giving a broadside in some way *previous* to ramming. If any member of this Institution will think that out, and try to ascertain how, previous to ramming, you can deliver the broadside to the ship you are going to ram, I think he will discover, and agree with me, that such a thing is not possible.

When we come to the distribution of armour, we have the first question put to us, "Is armour retained in ships of war to protect the gunners or to protect the ship?" and I think that the Navy generally would say, as Sir John Hay has said, "protect the ship first," and "protect the gunners afterwards." But I am not quite sure that it is certain that we cannot protect the ship with a less quantity of armour. We have been told by Sir John Hay, very properly, that we have to protect the ship not only against artillery, but against torpedoes and against ramming. Now it has often been put forward that there may be the proper protection for the hull, not in thick armour, but in a cellular system. We had a very excellent illustration of the value of the cellular system from Mr. Barnaby at our last meeting, where he showed us the accident that happened to the "Northumberland," and how complete her cellular protection was. But passing on from that—if we are to say that we can only protect the hull by armour, then the reply of the Navy universally would be, "protect the ship, and after that protect the guns and gunners." But I think that there is a general feeling in the Navy that the assumed answer to the second question Mr. Barnaby puts is the right one; he says, "*if for both purposes*," and I think the Navy generally believe that we ought to apply armour to both purposes. Sir John Hay made use of a very strong expression, in which I am sorry to say I do not quite agree with him. He said, armour was worse than useless unless it was a complete protection. Now that is a dictum that I demur to. I have always looked at it in this way—that the value of armour is simply this—"*to compel your adversary to fire so many fewer shots at you in any given time*," and I am satisfied that every inch of armour you put on the ship, effects that purpose. You compel him to carry heavier guns, and by compelling him to carry heavier guns, you compel him to fire fewer shots per minute, and therefore I look upon even a small amount of armour as a very valuable thing. It has been rather put to us to-night that there is a possibility, and Admiral Touchard seems to express it very strongly, that an unarmoured ship, with very great gun power, might successfully meet in the open sea an armoured ship. Mr. Barnaby assumes, I observe, that it is almost necessary that a ship when she is heavily armoured, should have few effective guns; that is a point that I demur to. She will have few effective guns as against a ship heavily armoured; but it does not follow that she will have few effective guns as against a ship which is not armoured at all. The battle of Lissa was referred to by Sir John Hay, and there we had a lesson which seems to me to settle that question, so far as Admiral Touchard goes, completely. The "Kaiser," the two-decker, an unarmoured ship, which did as good service as she could in that battle, was out of the action very early in the proceedings, and her loss in killed and wounded was two-thirds of the whole loss of the Austrian fleet. I think that is a fact which settles the question completely. Here was a ship such as Admiral Touchard would wish for, I suppose, with a large number of guns. She was set on fire in two or three places. She lost her masts, was thrown out of action altogether, and became quite a burden to the fleet; and she lost two-thirds of the whole loss of the Austrians. The Lecturer lays great stress upon the armouring of the bows and sterns of his vessel, and Admiral Touchard, I think, lays great stress upon the same thing. (Mr. BARNABY: The bow only.) In the course of Mr. Barnaby's lecture he pointed out to us that the "Glatton" turret was so small an object that its real defence lay not in the thickness of armour-plates upon it, but in the smallness of its size, so that it could not be hit. Now I look upon it that the bow of a ship is in precisely the same condition. It will be a most difficult thing to hit the bow of a ship at all. It is a very small target, and I think you had better trust, where you are seeking to save weight in every way you can, to the smallness of the target than to the thickness of the armour you put upon it. There is one thing that I can see through this discussion, namely, that it is quite clear we have not settled in the least how we propose to fight our battles; and I am

persuaded that until we have taken some steps to settle how we are going to fight our battles at sea it is very little use our trying to build ships to take part in battles that may not afterwards be those which we shall be called upon to fight.

Commander W. DAWSON, R.N.: I should like to correct an erroneous impression which might be caused by a statement made by me at the previous discussion. I then congratulated the Controller's department on the fact that they had discovered that a ship-of-war was built for the purpose of carrying guns and making holes in hostile ships, and not exclusively for keeping out hostile shot. I supposed that that principle had been carried out in the design of the "Téméraire" placed on the walls. My congratulation, however, referred rather to the principles laid down by Mr. Barnaby in the paper than to the design for the "Téméraire." It was only when I got home and began to reflect still further upon this important and valuable paper, that I found the offensive power given to the "Téméraire" did not embody in an adequate degree the principles of armament so ably enunciated by Mr. Barnaby. The ever-decreasing character of naval armaments is shown by comparing the weight of ordnance carried by successive types of ironclads. The "Northumberland" carries 261 tons of ordnance, but the "Hercules," with thicker armour, carries only 197 tons of ordnance, or somewhere about one-fourth less; whilst the "Bellerophon" carries only 145 tons of ordnance, or little more than one-half the offensive force of the "Northumberland." Now this new "Téméraire" carries only 165 tons of artillery, so that offensively she is about two-fifths less powerful than the "Northumberland." The abandoned design before us would have carried a slightly greater weight of ordnance than the "Northumberland," for she would have had 272 tons. Now, as I place the greatest reliance upon the offensive power of ships in battle, which, with guns of equal perforating power on both sides, would be far more decisive of victory than their defensive armour, I would on that ground have been prepared to adopt the abandoned design. But I am not quite sure that it would be wise to go so far as Sir John Hay proposes, and as is proposed in the abandoned design, by abandoning armour protection altogether. I fully concur with what has fallen from my friend, Captain Colomb, that there is a great benefit derived from comparatively thin armour in obliging the enemy to carry heavy ordnance, and thus to fire few shot which will not perforate at great angles. For example, let a ship with 4½-inch plates, like the "Warrior," be opposed in action by an unarmoured ship such as the "Narcissus," and the case will be represented to perfection. Not one of the "Narcissus's" guns, as at present armed, could perforate the "Warrior's" armour under any circumstance; whilst even the boat's guns of the "Warrior" would do good destructive work against the sides of the "Narcissus" at almost any angle of incidence. So that whilst the "Warrior" would be quite safe against the "Narcissus," the "Narcissus" might be riddled at leisure even by the boat's guns of the "Warrior." Your thin armour, therefore, compels the enemy to re-arm his fleet. That re-armament, or re-distribution of ordnance into fewer and heavier pieces, is one of the most urgent necessities of our own fleet—namely, that existing vessels, armoured and unarmoured, should be all re-armed, so as not to be compelled to run away from a thicker sided foe, but be competent to fight whatever ships of equal weight of metal they may happen to meet. This can only be done by increasing the velocities of the shot or their weight, and though it is the rifling which causes British guns to have "decidedly the lowest velocities," yet an increase in the weight of the guns would be necessary to secure perforation in all cases. The point which I wish to emphasise is that the power of the ship is not to be measured by the thickness of the armour, but by the force and number of the blows she can give the enemy, and her power of artillery penetration.

Captain SELWYN, R.N.: I shall ask to be allowed to say a few words upon the questions that Mr. Barnaby has proposed to us, and I may say before I do so, as Major Moncrieff has been adverted to, I know that he is at this moment engaged at Newcastle inspecting a gunboat built for the Dutch in which his principle has been applied on the hydropneumatic plan, and which I believe has been a perfect success. There is no difficulty whatever on that principle in bringing any gun you like to use, entirely below the water-line whenever it is not actually firing. That disposes of the question in great measure as to covering the guns.

With regard to the question for what purpose we put armour on our ships, I

think my naval brethren have given a very short answer to that. Not even Mr. Plimsoll, with all his value for Jack Tar's life, could ever persuade sailors to think the ship that carried them was not worth more than any of their individual lives. We are all willing to abide by the ship that carries us, and we want her protected first and before all. But we want her protected intelligently; we do not want a quantity of iron devoted to protecting the ship which really neither protects the guns nor the ship. In the enormous broadsides which we see in our modern armour-clads, I should like to ask how much of the armour actually protects the ship's life, and how much actually protects the lives of any men fighting the guns? how much, again, protects the machinery, if it be properly placed where it ought to be placed, within the protection of the water? It is the want of skill in the distribution of the weight; the idea that it was necessary to armour-plate the whole outside, that has led us into the difficulty which I am happy to see Mr. Dudgeon says is no difficulty at all, of not being able to carry enough armour where it ought to be placed and where it is wanted. If we carry our guns below the water-line, and by dint of intelligent machinery are able to bring them up to fire, we certainly do not want armour to protect the guns, and equally little to protect the crew, because they remain below water. We should want armour very much indeed to protect the machinery of the guns if we were to attempt to carry guns "*en barbette*." That is a term that I do not accept as applicable to anything which floats on the ocean. *En barbette* is to be applied where the plane is absolutely steady at all times and in all weathers. That is never to be expected in the case of a ship. Whether it be from the curved fire of a distant enemy, or from the rolling and other movements of your own ship, a barbette gun is exposed in every direction; and the same objection precisely applies to any idea of a traverse at the bows or stern of a ship. There is no time during the approach of two ships to each other from the distance at which they begin firing till they come up very close to each other, at which they may not expect to receive a plunging fire, whether of grape or shrapnel, or even of shot and shell bursting at proper distances all along that deck, in spite of the traverse at the bow. Therefore I do not regard any contrivance which is thought out simply as though the ship were constantly floating on a plane, as having any value whatever at sea, and I should beg the reconsideration of that whole subject.

I will now proceed to the question of how much armour ought to be given to the guns and to the ship. I have shown that really no armour ought to be necessary for the guns at all: how much, then, is necessary for the ship? In the case of the ram and torpedo, there is no possible thickness of armour and no possible protection on which we could rely. One of these ships going at five knots, let alone ten, twelve, or fourteen, would drive through armour and everything else, as if it were so much pasteboard, and I do not believe that there will be any of the little fiddling about, so beautifully word-painted by Admiral Touchard, but which would simply result in saying, "I will give you a little poke in the ribs now, and then I will go away and just touch you somewhere else." The very first time a ship is fairly struck by a ram, unless she is very much more protected than she is now, she goes to the bottom, that is quite certain, and with very little damage to the attacker, wonderfully little damage to the moving object. Admiral Sir George Sartorius foresaw a great deal of this, and I think if his opinions had been more weighed at the time, we might have got faster forward than we have. As Sir John Hay has said there is another question which will answer many of these questions. Why do not I want any protection from torpedoes? Provided that it does not blow the ship to pieces altogether, no amount of water that could enter the ship would suffice to sink her, if that ship were moved by a turbine propeller. Secondly, Sir John Hay very properly said, speed was one of the great conditions we seek. Why is it undervalued? We say, speed can be obtained by the turbine propeller which no other form of propeller will give, simply because it is not dependent on the immersion of the propeller for the degree of propulsion it can give. As the late Mr. Murray told you here, its power is simply dependent on the engine-power you can develop in the ship; you can drive the ship at any speed you please, of course with a certain increase of boiler power. Therefore no armour is necessary to secure the ship against sinking if she be properly engined. Her steering power, another great point, as Sir John Hay has said, is very much subject to that question of the turbine; we do not want armour

again for the stern. I do not care about the rudder; the rudder is of no more account to me for the purpose of steering. The instant I get a proper propulsive engine I do not want to protect the bows at all, because I do not propose to place the guns there, and having no idea that when I can use the ram, the gun will be used in preference. I may confine my armour then very much to the interior of the ship, not to the exterior. It is quite possible to build ships well without putting armour outside their skins. The skins will not be much hurt by being pierced above water; you may allow them to be pierced as much as you please. If you wish to do it, you may confine your armour inside to a very much smaller perimeter than your external outline. That will economize weight. If you try to do away with armour altogether, I join entirely with my brother officers in saying, you can never persuade me that the man who is not protected from any shot or shell, is better off than he who is protected against some, but not all; and you can never persuade me that human beings will fight better in proportion as they have less protection. Let us lighten the ship reasonably. Let us strive rather to accumulate our protection on those points which do need it, and do away with it on those points where it is not essential, and on which Officers at sea will tell you we could very well do without it. We would much rather that you would not load us with great weights at the bow and stern; we will sacrifice a great deal in order to keep the weights out of the bow and stern, for the ship will be more handy, more ready to encounter heavy weather, and will strain less at sea. The first weights we have always got rid of at sea, when in danger, are those of the extremities. Then, if you send us to sea in vessels with masts, let us have masts so placed and so proportioned that the ship will wear and stay with these masts, for if she will not, you had better never put them there at all. As for impossible sails calculated on centres of effort which do not exist at sea, things which no seaman on earth can handle in any sort of way, I say, sweep them away altogether, do not give us a pretence, do not jury-rig us on leaving port. I think there is talent sufficient in the Navy, and I hope in the Controller's Department, to put masts where they ought to be in the ships. I am sorry to say we have not seen that very desirable circumstance fully carried out in the ships which have been sent to sea of late years; they have been more remarkable for the extreme persistence with which they pursue a straight course when their captain wishes them to turn round, and with which they turn round when their Captain wishes them to do the reverse. They are not seamen's vessels; in fact, I have often said before, they never will be seamen's vessels till those who build them first pass some portion of their early life at sea. It will conduce very much to their health, and I hope to their knowledge.

The CHAIRMAN: I did not come here to discuss these points, but to hear the opinions of various gentlemen. From what has been said, and the opinions that have been expressed, it appears that most Officers are of opinion that the first point, in answer to Mr. Barnaby's questions, is to protect the vessel from being sunk by shot, or by a ram, or by torpedoes; but that when you come to add by a ram, or by torpedoes, it makes it a very difficult question indeed to answer, how you are to dispose of this iron—how you are to protect her, if she is to be protected with iron—where you are to put the iron. It is quite clear that a narrow band of iron round a ship will not protect her from a ram, and it is also as clear that it will not protect her from a torpedo. The gentleman who has just spoken and Sir John Hay have rather a good opinion of the turbine. The turbine is good so far as this, that almost the larger the hole in the ship's bottom, the better the turbine will work. That is all so far true, if you can calculate upon a reasonable hole, but what I contend is,—and I am afraid it will be the case whenever any of these torpedos get under a ship's bottom,—that they will knock the whole bottom to pieces, turbine and everything else, and the vessel will be down in five minutes. There is the difficulty. I dare say you all know that torpedoes are now contrived with internal machinery that works not by steam, but by compressed air. These torpedoes will go at the rate of 8 or 9 knots for a considerable distance, and carry a sufficient charge when they strike or get under a vessel, certainly to blow her up.

Then, with regard to protecting the guns. I think it has been advocated that you had better have a good number of guns. Well, if you have a number of guns, it is quite impossible to protect them by armour. I have a great objection to go

back to the old system of a number of guns. What we ought to have is, few guns and heavy ones, and those few guns in turrets. What I believe to be about the most powerful vessel that could be constructed now-adays would be a ram, with one turret and two 35-ton guns. It would take very little armour to protect these guns, and the armour that protects the guns will protect the men. In fact there are no men to protect, for in the turret with two 35-ton guns you need not have above three men in the turret; all the rest of the crew can be below, under water. By the machinery we have to work these turrets with, the men are not in the portion of the turret in which the guns are fired; they are down below working the winches. With regard to the question whether armour that will not keep out shot, is worse than no armour at all, I think any Officer that had to choose between an unarmoured ship and one with the "Warrior's" armour would say, "I will take "the 4½ inches, for that is better than nothing. I will never if I can help it, let "them have a fair shot at me. If I have the heels of my enemy I will keep my "bow on;" and 4½-inch armour will keep out a shot from an 18-ton gun, unless it is a fair hit, and any gentleman who has been at sea will know that it is rather difficult to get a fair hit.

With regard to what Sir John Hay said about what vessels we want, I think that is the most important point of all. The vessels that we have got, or the vessels that we are now building, what are they fit for? What will they do? We are building a set of vessels now without masts, the most powerful vessels that have ever been built as far as guns go, but nobody knows what they will do. I understand they are built for sea-going ships, not cruising ships, but ships fit to go to sea whenever the service requires it, and to go abroad. Now we are not agreed upon that. Many naval Officers and architects say that these ships are fit to go anywhere. I have always had my doubts about it, but I never objected to build one. I was always an advocate for building one of those ships on trial. When Captain Coles was allowed to build his ship, we were of opinion that that ship never would be an efficient sea-going ship, nor a safe ship at sea. But there was a great difference of opinion on the subject. The public took up the idea and backed up Captain Coles, and what I said then was, let them build a vessel on trial. The Government allowed Captain Coles to build a vessel on trial, but we thought that Captain Coles' plan would not make her sea-going. We recommended a vessel like the "Monarch." Captain Coles' vessel was tried for a long time at sea, and it was thought that she was perfect. People began to say, "How mistaken you "were; how little you know about sea-going affairs;" and then we know how she was unfortunately caught in some particular sea, and a puff of wind sent her to the bottom. This shows that we ought never to build ships upon new designs without, the moment we have got one launched, giving her a fair trial—not a trial such as when a ship goes off in smooth water with a common sea in the channel and with an easterly wind—but whether she will stand an Atlantic swell. You have heard that the height of the Atlantic waves have been calculated at from 20, 30, 40, to 50 feet, and Admiral Fitzroy gives very good reasons for saying he has seen waves 60 feet high. When you build these low free-board ships to go to sea with a high centre of gravity, which is one of the most material points, I repeat you ought never to build a second until the first has been tried upon the point of seaworthiness.

Captain HOSEASON, R.N.: Is it out of rule for us to ask Mr. Barnaby, as he has kindly brought a new plan of a ship before us, if he would explain some other points connected with her besides those about the gun-battery? I should like to ask whether that is a full masted ship or not, and what her capacity for fuel is? There are also two ways of considering the value of a ship's battery at sea: in the one a ship that can steam long enough to keep a small battery for a *month* at sea, in the other, that of a ship that can only steam long enough to keep a larger battery a *week* or a *fortnight* at sea. The question turns upon the different services to which you wish to apply the ship, and it is a question whether a vessel with a less number of guns and more fuel is not under certain conditions much more efficient than another vessel with more guns and with less fuel. We know nothing about that ship (pointing to the diagram) except as regards her gun battery. We do not know whether she is a full masted ship or not. I have had a pamphlet kindly sent to me by Sir Thomas

Symonds, in which he designates all our ironclad ships as built on an insane principle of being over-masted. I want to know if this ship is one of those that will come under that category. It is evidently a new ship, and, I believe, she is approved of. What is her sail power?—what is her steaming power?—and what is her speed?

Mr. BARNABY: This (open battery) ship of course does not exist at all: the question is put to me with regard to the "Téméraire." The "Téméraire" will have two masts only.

Captain HOSEASON: Auxiliary area of canvas or primary?

Mr. BARNABY: With about the same area of canvas as is given to the armoured ships of the "Iron Duke" class. The speed under steam is expected to be 14 knots. The coal endurance will be at least 50 per cent. better than that of any of the present ironclads.

Captain HOSEASON: Is that due to improved engines, or to the quantity of coal carried? Do you mean to say she will carry 50 per cent. more coal?

Mr. BARNABY: I do not.

Sir JOHN HAY: Not the "Devastation"?

Mr. BARNABY: No, the masted ships. The quantity of coal I am speaking of is the quantity called the complement of the ship; but the Controller of the Navy has insisted on having the bunkers made large enough to carry a much larger supply of coal than is usually carried.

Captain HOSEASON: What is the amount?

Mr. BARNABY: It is not of much value to tell the amount, because the size of the ship ought to be taken into consideration.

A VISITOR: How many days full steaming?

Mr. BARNABY: About 3½, but that is not the way in which the matter should be looked at.

Captain HOSEASON: It is not the way I should look at it, but I should better understand it if you will give me the *bonâ fide* number of tons.

Mr. BARNABY: The "Téméraire" will carry 500 tons as her complement; she carries 700 tons, but 500 tons is her complement.

Captain HOSEASON: What is her displacement?

Mr. BARNABY: 8,300 tons.

Captain HOSEASON: Then her economy is entirely due to the principle of the engines.

Mr. BARNABY: Entirely, but the bunkers are made large enough to contain a larger quantity of coal than is the proper complement of the ship.

The CHAIRMAN: The vessel is not a fully masted ship?

Mr. BARNABY: She is masted like an ordinary ironclad.

Captain HOSEASON: Is she masted as much as the "Bellerophon"?

Mr. BARNABY: No, because she has two masts and the "Bellerophon" has three.

The CHAIRMAN: The question about them all is, that they are unmanageable. The hull is so heavy for the force of the sails that you cannot manage them. They have not sail enough. Is this ship masted in the same proportion as the other ironclads?

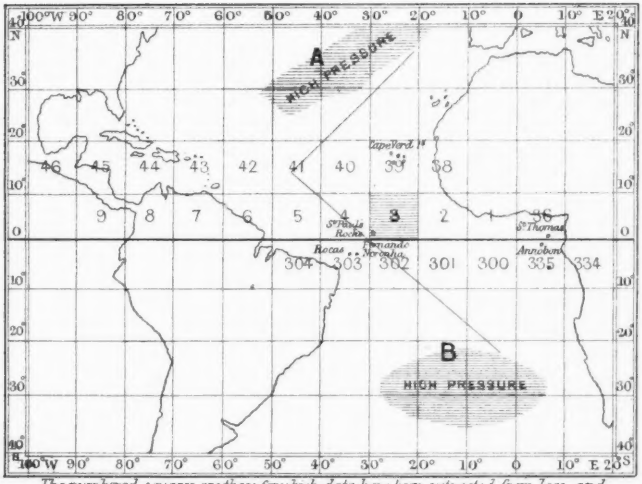
Mr. BARNABY: We are getting now into the very important question, "How are "you going to mast ironclads?" which needs half a dozen lectures in itself. There are gentlemen who believe that you can make an ironclad sail as you can make ship that is not armour-clad, but you cannot do so.

General SCHOMBERG: Would you allow me to ask Mr. Barnaby whether he would describe how the French guns are placed, in order, as Admiral Touchat states, to deliver a broadside before ramming?

Mr. BARNABY: The idea is impracticable, I think. Allow me now to say that I am very much indebted to the gentlemen who have been kind enough to help us to discuss these questions this evening.

The CHAIRMAN: In the remarks I made with regard to the trial of the new ships I did not allude to the necessary trials with regard to their stability, but when they are forced against those seas. I think, gentlemen, you will allow me to thank Mr. Barnaby for the very excellent lecture which he gave us; and I hope that some good result either to us or him may follow from the discussion. The great point in all these discussions is, if possible, to come to some decided conclusion; we vary in opinion, and very often the subject is left as open and wide as when we began.

DIAGRAM 1.



The numbered squares are those for which data have been extracted from logs, and sifted into 1° sub-squares.

A *and* **B** *are areas of high barometric pressure which supply air to the Trade and other winds.*

J. Jobbins

LECTURE.

Friday, April 4th, 1873.

Vice-Admiral SIR FREDERICK W. E. NICOLSON, Bart., C.B.,
Vice President, in the Chair.

THE METEOROLOGY, SEA TEMPERATURE, AND CURRENTS OF THE 10° SQUARE OF THE ATLANTIC, WHICH LIES BETWEEN THE EQUATOR AND 10° N., AND FROM 20° TO 30° W.

By Captain H. TOYNBEE, F.R.A.S., Marine Superintendent, Meteorological Office, Board of Trade.

MUCH good work has been done by Maury, whose death we have now to lament after a long and able life chiefly devoted to the Science of Meteorology, also by Admiral FitzRoy, the Hydrographical Department of the Admiralty under Admiral Richards, and others, towards representing in a general way the wind and other weather data of the Atlantic; but now that the Meteorological Office has been supplying standard instruments for 18 years on the plan commenced by Admiral FitzRoy, and receiving logs in which the force of the wind is always entered, it seems right that certain important parts of the sea should be dealt with in a more special way.

As the Equatorial Doldrums are of the greatest importance to navigators, especially in sailing ships, it has been decided to commence with them.

Here it may be well to say that the doldrums are the calms and unsettled weather which exist between the trade winds; they travel N. and S. after the sun, and pass twice in the course of a year, through the square with which we are about to deal. If any of my hearers are afraid of forgetting their name, they have only to pass *once* through them to have it impressed on their memories for ever.

The 10° square (No. 3 of Mr. Marsden's numbered squares) extending from the Equator to 10° N., and from 20° to 30° W., has been selected as the one of most importance, and in which the largest number of observations have been collected.

In that *zone* of the Atlantic which lies between the parallels of 20° N. and 10° S., shown on diagram 1 by the numbered squares, we have extracted nearly 125,000 observations, and, although they extend

over the twenty-six numbered squares, we find that nearly 60 per cent. of the whole were taken in No. 3 SQUARE, which, for distinction, is slightly *shaded*.

The data for this square have been sifted into monthly charts containing a hundred 1° sub-squares; that for January was lithographed and circulated amongst scientific and practical men interested in the subject; the result has been a large number of suggestions which are embodied in the chart, containing twenty-five 2° squares, now exhibited. It gives graphic representations of the direction and force of wind, the amount of calm, and the prevailing currents, besides giving the original observations. Reductions of the diagrams I am about to use will be on the corners of the charts.

Mr. Francis Galton, who submitted a short memoir in 1866 to the British Association (Transactions of Sections, p. 17), on the new principle of "passage charts," has very recently sent an elaborate communication on the same subject to the Royal Society, which will be read at an early meeting after Easter. In this memoir, he not only shows how to compute the mean distance sailed in a day, in any direction, in any square, by ships of a specified class, but he explains how the tedious calculations may be wholly dispensed with by the use of a small machine; he also shows how isochronic charts are to be constructed, and how they are to be used in connection with the actual and probable conditions of wind under which a navigator may find himself.

In the last letter which I received from the much-lamented Maury on the subject of the January Chart of one degree sub-squares, which had been sent to him, he said:—

"Being such a highway, in which observations are so frequent, and being in a meteorological position of such importance as it is, viz., at the meeting of the trade winds in the doldrums, and in the wedge of the westerly monsoon that feeds the springs of the Niger; all these circumstances conspire to make it an inviting field of research. Wisdom has been displayed in the selection of this square for minute investigation."

"These investigations are in continuation of the wind and current charts, and they not only confirm several important discoveries announced in the 'Sailing Directions,' as they were uttered, but they develop for the first time other phenomena of a highly important and interesting nature." . . . . . "This is a most valuable contribution to our knowledge touching the physics of sea and air. It is of practical use to navigators also, and I thank you heartily for it."

This letter was followed by another from his daughter, saying that her father had been very unwell, but was again convalescent, and hoped soon to write to me respecting the paper "On the weather which prevailed about the time that the 'City of Boston' was lost."

The promised letter never came, but very shortly afterwards we had the sad news of his death.

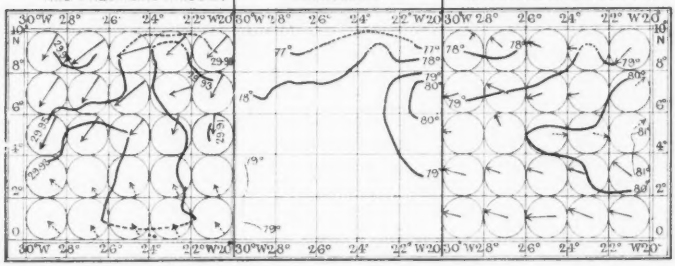
We will now, if you please, turn to the diagrams, and I must ask your particular attention for a few minutes whilst I endeavour to give a general idea of them. Although they are numerous, there are only

JANUARY.

ISOBARS FOR EACH .02 OF AN INCH AND PREVAILING WINDS ✻ †

ISOTHERMS OF AIR FOR EACH DEGREE FAHRENHEIT.

ISOTHERMS OF SEA FOR EACH DEGREE FAHT AND PREVAILING CURRENTS ✻✻



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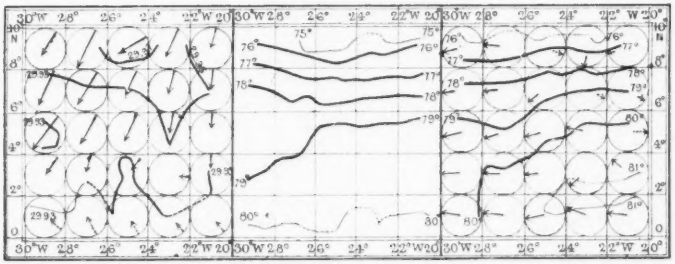
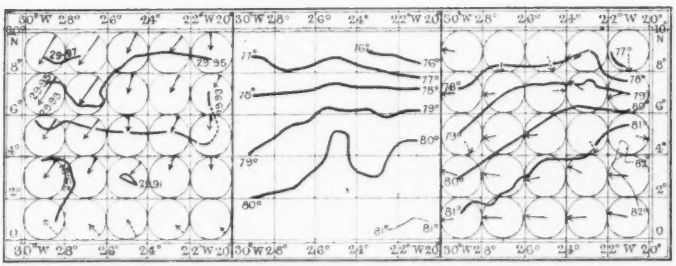


MARCH.



NOTE. When the Isobars or Isotherms are deduced from the data of 1° squares they are represented by a faint continuous line. Broken lines merely connect the different parts of an Isobar or Isotherm when the data does not authorize its being drawn.

✻ Each arrow flies with the most frequent wind of its square. Its length shows the mean force up to 5 of Beaufort's scale, and is proportional to the rate per hour at which the wind would drive Beaufort's Ship. Nine miles an hour force 5 extending across the circle.

† Northerly winds and Westerly currents have continuous, whilst Southerly winds and Easterly currents have dotted arrows.

‡ The length of the current arrows is proportional to the rate in 24 hours. 50 miles extending across the circle.

J. Jobbins

three for each month, and when you understand one set you will understand all. As already remarked, they are enlarged representations of the small diagrams which will appear on the lower right-hand corners of the charts for the various months, and which are published with this lecture; they represent—

1st. *Isobars*, or lines of equal barometric pressure for every two-hundredths of an inch, on which are drawn arrows flying with the prevailing or most frequent wind for the month in each 2° square. Northerly winds and westerly currents are shown by plain arrows, southerly winds and easterly currents by dotted arrows. The length of an arrow is in proportion to the force of the wind; if it amounts to 5 or more of Beaufort's scale, or 9 miles an hour of his ship, it extends across the circle.

2nd. *Air-isotherms*, or lines of equal air temperature for each degree Fahr.

3rd. *Sea-isotherms*, or lines of equal sea-surface temperature for each degree Fahr., on which are drawn arrows flying with the prevailing current for the month in each 2° square. The length of an arrow is in proportion to its rate in 24 hours, 50 miles or more extending quite across the circle.

My hearers must remember that winds are named after the direction *from* which they come, whilst currents are named after the direction *towards* which they go; for instance an arrow pointing to the north-westward represents a S.E. wind, but a N.W. current. In the diagrams, the *tails* of the wind arrows and the *heads* of the current arrows are made to touch the circle at the points of the compass after which they are named.

The remarks on Natural History are necessarily vague, sometimes because a Captain may not know the right name of a bird, fish, or other creature seen, at other times from his having an indistinct view of it; still they have been thought worthy of extraction.

January.

Isobars and Wind Arrow (see the monthly diagrams).—We will now turn to the isobars for January. That of lowest pressure (29·91) is on the eastern side of the square, and it increases to 29·97 in the north-western corner; they are also much closer together in the north-western corner than elsewhere. Now the relative length of the wind arrows shows that the N.E. wind is much stronger in this north-western corner, where the isobars are closest, than in the rest of the square, showing the relation between the difference of pressure and wind force.

The dotted southerly wind arrows are much shorter than the plain northerly, indicating how much stronger the N.E. trade is in these parts in January, than the S.E. This is a month in which the N.E. trade is pressing its way to the southward. By referring to the diagram for December, the eye can make a very fair estimate of the monthly change.

First, we find that the isobar of 29·97 which only just showed itself

in December has now pressed well into the square, in fact isobars 97, 95, and 93 have each come about 2° to the southward.

Then again the N.E. trade which only reached 6° N. in December, is now down to 4° N., and it has decidedly increased in force; between 6° and 7° N. we find that it has increased 0·7 of Beaufort's scale, or about $1\frac{1}{2}$ miles an hour of his ship.

The S.E. trade still prevails from the Equator to 4° N., but it has decreased very much in force over the whole zone, the decrease amounting to $1\frac{1}{2}$ miles an hour in the speed of Beaufort's ship. This seems to show how in January the rarefaction of the air, during the summer months of the southern hemisphere, has rendered the pressure to the south of the Equator, close to our square, nearly the same as in the doldrum, so that the greatest rush of air into the low pressure of the doldrum is from the northward, where the cold air lies low and heavy. We also find that in January there is a great increase in the percentage of upper cloud moving from the south-westward, whilst there is a decrease in that of upper clouds from any northerly direction.

Isotherms of Air and Sea.—The isotherms of air for January show that the hottest air is in nearly the same position as the lowest pressure and hottest sea; since December the coldest air and sea have made their appearance in the north-eastern corner of the square where the hottest had existed since October; this sudden change seems to be due to the southerly progress of the N.E. trade carrying with it the southerly and south westerly current along the coast of Africa.

A paper "On the Currents and Surface Temperatures of the North Atlantic Ocean," (Official No. 12) published by the Meteorological Office, shows that in December the sea-isotherm of 80° is in and to the northward of the north-eastern corner of SQUARE 3, whilst in January that of 70° nearly touches the same part of the square. These facts support the wonderful changes which we find since December.

Here attention may be called to the great similarity in the trend of the isotherms of air and sea, also to the fact that the sea is nearly 1° warmer than the air. This difference is very much the same throughout the year.

Current Arrows.—The plain current arrows show a prevailing and moderately strong westerly or rather W.N.W. current from 0° to 4° N.; whilst there is a westerly and sometimes south-westerly current from 6° to 10° N.; between these, in the neighbourhood of the hottest water, we find the dotted arrows showing an easterly current. Now the prevailing wind arrows show us that the easterly current is in the doldrums between the two trades, where there is little or no wind, but no doubt a heaping up of the water caused by the meeting of northerly and southerly winds, hence it is reasonable to suppose that when the wind which drove the water has stopped, it will return to the eastward as a back drift; it may well be the warmest water, for it has been the longest in the tropics. So here we find the lowest pressure, lightest wind, warmest air and water, and an easterly current in nearly the same part of the square.

On comparing the sea isotherms of January with those of December,

we find that the temperature of the sea has increased in the southern part of the square, whilst we have before remarked that it has greatly decreased in the northern. We cannot be surprised at this increase, for the water forming the westerly drift of the S.E. trade is brought up from a part of the sea which has been exposed to the southern summer's sun, whilst that brought down by the N.E. trade has been exposed to the northern winter. Now that the coldest water is in the northern part of the square we find the largest amount of dew there also; in December it was over the cold water to the southward. Another interesting fact is that with this increase of dew comes a large amount of red dust from Africa; in the north-eastern corner of the square there is 48 per cent. of mist or haze, whilst in the south-western there is only 5 per cent. In the north-eastern corner we have such remarks as:—

"Air very close and suffocating. Very damp. Sun not seen below "8°, on account of the thick haze. All the sails and ropes red."

So here we have, in the north-eastern corner of the square, a mixture of moisture and dust, which must remind all who have been in Madras during March, of the effect of the "'long-shore" southerly winds, which mix the moisture from the surf with the brick-dust of the roads, and produce a paste which partially closes the pores of the skin, and is believed by many to cause the boils which are so very common at that season.

Remarks.

Winds.—All steady winds, of a force of 7 or upwards, were from the north-eastward, also 64 per cent. of the squalls. The steady strong winds were all on the western side of the square. Between 3° and 5° N. there are terrific squalls from the north-eastward.

Currents.—An outward bounder, near St. Paul's Rocks (see the south-western corner of square 3 on Diagram I), had a strong westerly current of 2 miles an hour, still she got quickly to the southward, and only tacked to the eastward for 4 hours.

Clouds.—At the southern limit of the N.E. trade, upper clouds were seen to move from the south-eastward, whilst further north they came from the south-westward, as if they were affected by the motion of the earth.

Weather.—Lighting was most frequently seen on some northerly bearing, from 0° to 4° N., and on some southerly bearing from 4° to 10° N., indicating that its origin was where the two trades met.

Heavy chain-lightning and "corposants" were seen between 5° and 6° N. There was an awful thunder-storm, with "corposants," at the mast-heads and yard-arms, between 9° and 10° N., during which time the wind was southerly, though well in the region of the N.E. trades.

Natural History.—Very few land birds or insects were seen: they were chiefly in the doldrums, between 3° and 7° N.

Sperm Wales were seen between 4° and 5° N., and again between 8° and 9° N., both times going to the north-westward.

Falling Stars.—Falling stars were most abundant, in 1860, between the 1st and 5th instant.

Temperature of Rain.—The mean of ten observations showed the rain to be 2° colder than the air.

Various.—A severe shock of an earthquake was felt at 1 p.m., the 25th, 1859, within 10 miles of St. Paul's Rocks.*

Red dust was seen on the sails and ropes, chiefly between 7° and 10° N., where more than 40 per cent of the weather observations recorded mist or haze.

Best Route across the Equator.—A careful study of the data in SQUARE 3, and of that in the squares to the northward and south-westward of it, leads to the supposition that it would be well, for both outward and homeward bounders, to keep in its western half whilst passing through SQUARE 3.

FEBRUARY.

Isobars and Wind Arrows.—In February, we find the lowest pressure (29·93) ranging across the square in about 2° N., whilst that of 29·95 is in about 7° N., and 29·97 in 9° N. All have advanced to the southward since January, and the pressure of 29·98 frequently shows itself in the northern part of the square.

The isobars are still closest in the north-western corner of the square, where the prevailing north-easterly wind is strongest. The N.E. trade is not only stronger but more easterly on the western than on the eastern side of the square. From 2° to 10° N., between 20° and 22° W., the prevailing wind is nearly due north, whilst between 28° and 30° W. it is about N.E. by N.

The N.E. trade has gained 2° to the southward since January, and now extends to 2° N.

The S.E. trade has retreated 2° to the southward before the N.E., and decreased in force since January. It is strongest on the western side of the square.

Isotherms of Air and Sea.—The similar trend in the isotherms of both air and sea seems worthy of notice, as, also, the fact that the sea remains about 1° warmer than the air.

The air isotherm of 75° (being the coldest air in SQUARE 3, due to the N.E. trade), shows in the northern part of the square this month.

The temperature of both air and sea has decreased in the northern and increased in the southern half of the square. Between 9 and 10 N., the air has decreased 1°·8, the sea 1°·5, whilst, between 0° and 2° N., the

* The following is the complete extract from the log: "St. Paul's Rocks bearing N.W. by N. by compass, distant about 10 miles, experienced a severe shock of an earthquake, if that term may be applied to what occurred at sea. It commenced with a rumbling noise like distant thunder and lasted about forty seconds. I am perfectly familiar with earthquakes, having experienced many on the West Coast of America; but I never felt one so severe as this. Glasses and plates that were on the table jingled to a great extent, several articles were shaken off the after-hatch, and the ship felt as if grinding heavily on a reef of rocks, and that she was doing so found general belief, for the cry of "the ship's ashore" burst simultaneously from the lips of all on board, and the watch below came tumbling up in great haste. I must confess that I was very much startled, and ran to the side to look for the bottom, but I soon remembered what it was. During the first part there was a small confused sea, but after the earthquake a heavy swell from N.N.E."

air has increased 1°·5 and the sea 1°·1. There has been no change in the mean temperature of the air between 5° and 6° N., and none in that of the sea between 4° and 5° N. In spite of these great internal changes, the *mean* temperature of the whole square has not changed since January, but the difference in the position and trend of the various isotherms for the two months, shows the importance of this more minute work.

Current Arrows.—Westerly currents prevail in the square, the strongest being between the equator and 2° N., where the S.E. trade prevails.

Easterly currents still show, on the eastern side of the square, between 4° and 8° N., they are where the prevailing wind is northerly. Between 4° and 5° N., south-easterly currents prevail over all others.

Remarks.

Wind.—The remarks on wind show that there were some smart squalls in February, and that the wind is more unsettled on the eastern than on the western side of the square.

Currents.—There is only one mention of current rips between the equator and 2° N., whilst they abound in other parts of the square.

Clouds.—The remarks on clouds are similar to those for January.

Weather.—The remarks on the direction in which lightning is seen show that its source is where the two trades meet. Between 8° and 10° N. no lightning was seen.

Natural History.—No mention is made of any land birds or insects having been seen in February, as though the doldrums were too far S. for them. It will, also, be noticed that the prevailing wind on the eastern side of the square is northerly, instead of being north-easterly or more from the land, as in the previous three months.

Stormy petrels seem to have been most abundant between the two trades.

Various.—The only mention of red dust was between 7° and 8° N., on the eastern side of the square.

Best Route across the Equator.—In square 39 (see Diagram I), in February, the winds to the westward of the Cape Verdes are decidedly stronger than those to the eastward by about a mile an hour of Beaufort's ship; and, as our diagram shows them to be much stronger on the western than on the eastern side of SQUARE 3, there can be little doubt that both outward and homeward bounders should keep well to the westward, especially when we find that the homeward bounder would meet with a large percentage of north-westerly wind (the most trying of winds) on the eastern side of the square, whilst they do not exist on the western side. The winds near Cape St. Roque are favourable for getting to the southward in February.

MARCH.

Isobars and Wind Arrows.—In March we find the lowest pressure (29·91) in the south-western corner of the square. The lowest monthly mean pressure for the whole square (29·931) exists in March.

The isobars of 29·93 and 29·95 have shifted to the northward since February, and that of 29·97 still exists in the north-western corner of the square. There has been a general decrease of pressure in the square, owing no doubt to the northern advance of the sun; the greatest decrease (·019) was between 2° and 4° N.; between 9° and 10° N. it had increased.

The isobars are still closest in the north-western corner of the square, where the relative length of the wind arrows shows that the strongest wind prevails; the wind arrows also show that the N.E. trade is still much more easterly in the western than in the eastern half of the square. North-westerly winds are common on the eastern side of the square.

The N.E. trade is more decided between 2° and 4° N. than in February: it has, however, slightly decreased in force generally. In February the northern part of the square was cooling whilst the southern was heating; now the whole is getting warmer, which may account for the decrease in force of the north-easterly wind.

The S.E. trade still prevails from the equator to 2° N., and is very little changed in force since February; it is strongest on the western side of the square.

Isotherms of Air and Sea.—The similarity in the trend of air and sea isotherms still holds, as also the fact that the sea remains about 1° warmer than the air. Their drooping to the southward on the western side of the square is no doubt a result of the stronger north-easterly wind there.

The mean temperature of both air and sea in the whole square has increased about 0°·6 since February, most in the south-eastern part of the square: the greatest increase was between 3° and 4° N., where it averages 1°·2 in the air, and 1° in the water. It seems worthy of notice that the greatest decrease of pressure has taken place where there was the greatest increase of temperature in air and sea.

Current Arrows.—The plain arrows show that westerly currents prevail generally, and are strongest in the southern part of the square.

The dotted arrows show that south-easterly currents prevail in the north-eastern part of the square, where the wind is chiefly from the northward, and not unfrequently from the north-westward. The chart of 1° sub-squares shows a large amount of southerly current between 7° and 10° N.

Remarks.

Wind.—The remarks on wind show that the N.E. trade acquired great force at times.

Clouds and Weather.—Those on clouds and weather lead to very similar conclusions to those derived from January.

Natural History.—A very large number of stormy petrels (nearly a hundred at once) were seen in the doldrums between 1° and 2° N. and 21° and 22° W.

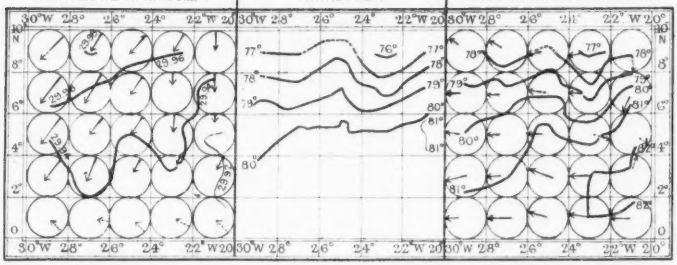
General.—Red dust is met with to the northward of 6° N. No land-birds or insects were seen, which may be well accounted for by the winds being so northerly on the eastern side of the square.

APRIL.

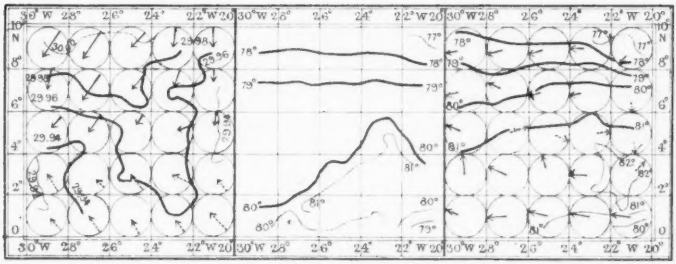
ISOBARS
FOR EACH .02 OF AN INCH
AND PREVAILING WINDS.* +

ISOTHERMS
OF AIR FOR EACH DEGREE
FAHRENHEIT

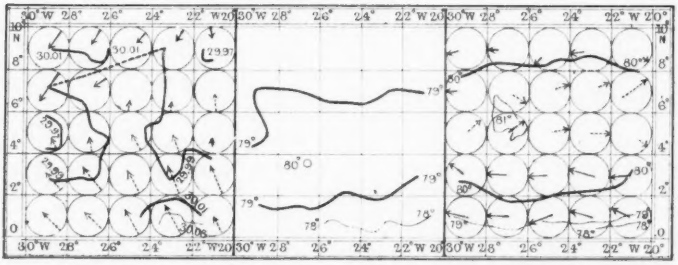
ISOTHERMS
OF SEA FOR EACH DEGREE FAHT
AND PREVAILING CURRENTS† ‡



MAY.



JUNE.



NOTE. *When the Isobars or Isotherms are deduced from the data of 1° squares they are represented by a faint continuous line. Broken lines merely connect the different parts of an Isobar or Isotherm when the data does not authorise its being drawn.*

* *Each arrow flies with the most frequent wind in its square. Its length shows the mean force up to 5 of Beaufort's scale and is proportional to the rate per hour at which the wind would drive Beaufort's Ship, Nine miles an hour (force 5) extending across the circle.*

\+ *Northerly winds and Westerly currents have continuous, whilst Southerly winds and Easterly currents have dotted arrows.*

‡ *The length of the current arrows is proportional to the rate in 24 hours. 50 miles extending across the circle.*

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Best Route across the Equator.—In square 39 we find the strongest winds to the westward of the Cape Verde Islands in March, and they are decidedly stronger on the western side of SQUARE 3. The winds near Cape St. Roque in March are favourable for getting to the southward, so that an *outward-bounder* should keep well to the westward, and might safely cross the line in 27° W. A *homeward-bounder* should certainly keep to the westward.

APRIL.

Isobars and Wind Arrows.—In April pressure has generally increased about 0·01 in., and the isobars run more north-easterly and south-westerly in their direction.

The greatest increase of pressure has been between 2° and 4° N. where the lowest pressure existed in March. This shows how gradually nature provides for the northern advance of the doldrum and its following S.E. trade, for in May we shall find that south-easterly winds prevail between 2° and 4° N., which could not be the case if there were not a higher barometer there than in the zone to the northward.

Both pressure and temperature have increased this month, which is rare; perhaps it is a kind of heaping up of the air before the increased activity of the S.E. trade sets in, causing freer egress to the upper current. The great amount of easterly wind experienced in higher northern latitudes at this season may be related to this heaping up of air in the doldrums; for before easterly winds can blow in our islands, the barometer must be higher to the northward than to the southward of them, and any check to the upper current which supplies air to the area of high pressure in about 35° N. would tend to produce such a state of things.

The plain wind arrows show that the strongest north-easterly wind is still in the north-western corner of the square; that the N.E. trade has increased in force between 2° and 4° N., especially on the western side of the square; also that between 20° and 24° W. the prevailing wind is still very northerly.

The dotted wind arrows show that the S.E. trade prevails up to 2° N., and that it is weaker and more easterly than the N.E.

Isotherms of Air and Sea.—The isotherms of air and sea are remarkably similar in their shape and position. The air still remains one degree colder than the sea. From the equator to 2° N. there has been a slight decrease in the temperature of the air, whilst that of the sea has increased. The sun having been a month in the northern hemisphere, we may expect the air of the S.E. trade to be cooler, as it would feel the change sooner than the water. The temperature of both air and sea is remarkably uniform from 0° to 5° N., but there is a gradual decrease of about 1° Fahr. to each degree of latitude between this and 10° N.

The hottest air (81°·4) and sea (82°·6) experienced in the southern part of the square during the year, appear in its south-eastern corner in April.

Current Arrows.—The plain current arrows show that westerly currents are the most prevalent throughout the square, whilst their relative lengths indicate that they are strongest in the southern part of the square.

The dotted current arrows show a back-drift to the eastward, near the spot where the hottest air and water are met with. By referring to the wind-chart for April we find a large per centage of light north-westerly winds and calms where this easterly current prevails.

Remarks.

Wind.—Very heavy squalls were frequently experienced, especially between 2° and 3° N., where some ships lost masts and sails.

Currents.—Current rips were very abundant throughout the square. It will be noticed that the prevailing wind blew very much across the prevailing current, especially in the northern part of the square.

Clouds.—The upper clouds were frequently from S.E. when the wind was N.E., as remarked in January.

Weather.—The largest per centage of lightning prevails between 3° and 4° N. The largest per centage of mist is between 6° and 7° N. It has decreased in amount since March.

Natural History.—Two swallows were seen in the doldrums between 3° and 4° N. A moth between 4° and 5° N.

A hawk devouring a stormy petrel as it flew, between 5° and 6° N.

A butterfly between 6° and 7° N.

Various.—Red dust was twice seen on the sails and rigging of ships between 7° and 8° N.

Best Route.—In April we find that the strongest winds are to the westward of the Cape Verde Islands, especially in the southern part of square 39°. The prevailing wind arrows show that the western side of SQUARE 3 has much the strongest winds. Then again we find that April is a good month for getting to the southward near Cape St. Roque, for although the winds are lighter than in other months, still they are very easterly in direction, so that a ship may safely cross the equator to the westward of 25° W.

MAY.

Isobars and Wind Arrows.—Pressure has generally increased about ·02 since April. The isobars still have a north-easterly and south-westerly trend.

The greatest increase of pressure has taken place in the northern and southern parts of the square, though it has been very equally distributed.

The plain wind arrows show that the N.E. trade has retreated 2° to the northward since April, and grown weaker in force, also that it is still much more easterly and stronger on the western than on the eastern side of the square.

The dotted wind-arrows show that the S.E. trade has advanced 2° further N. since April, and increased in force.

Isotherms of Sea and Air.—The isotherms of sea and air are still

very similar in their position, and the sea is about 1° warmer than the air. With both there has been a decrease of temperature since April in the south-eastern corner of the square, which is no doubt a result of the increased force of the S.E. trade. In the 1° sub-square, which is in the south-eastern corner of the square, the decrease of temperature is more than 2° since April. The temperature of both air and sea has increased in the northern, and decreased in the southern part of the square, so that the mean for the whole square is the same as that for April. The air is a little in advance of the sea in its changes, as would be expected, making it as warm as the sea in the N.

Current Arrows.—The plain current arrows show that westerly currents prevail, that they are stronger and more north-westerly in the southern than in the northern part of the square, where they are chiefly slightly S. of W.

The dotted current arrows show how the easterly current has gained ground with the decline in the force of the N.E. trade, also that it is still most common on the eastern side of the square where the winds are very light.

The distribution of wind and current in the square is very similar to that for January, only now the S.E. trade is advancing, whilst the N.E. is receding. It will be noticed that there is also a slight resemblance in the trend of their isobars and isotherms.

Remarks.

Wind.—The remarks on wind show that squalls were more abundant in May than in April. Very heavy squalls were most abundant between 5° and 6° N., where two whirlwinds were experienced.

Clouds.—The amount of cloud generally, as well as of rain, has increased considerably since April, probably caused by the in-rush of cold air from the southward.

Natural History.—A dragon-fly was seen between 4° and 5° N. Several land birds between 6° and 7° N. A hawk between 7° and 8° N., and a snipe between 9° and 10° N.

Various.—No red dust was reported in May.

Best route across the Equator.—In square 39 the *outward bounders* will find a stronger and more steady N.E. trade on the western side of the Cape Verde Islands. To the eastward of those islands there is a large percentage of N.W. winds, which are lighter than the N.E.

In SQUARE 3 the best wind seems to be in about 26° W., but perhaps it would be well to strike the parallel of 4° N. in about 24° W., as there is a S.E. trade and westerly current to the southward of this latitude, and the winds near Cape St. Roque are more southerly than in the previous months.

The *homeward bounder* would certainly do well to pass the parallel of 4° N. in about 26° W., seeing that he will thus escape thealarge amounts of light north-westerly and northerly winds which prevail in the north-eastern part of the square.

JUNE.

Isobars and Wind Arrows.—Pressure has increased at a mean

amount of ·034 over the whole square since May; this is the greatest increase during any month in the year. When we come to analyze this increase, we find that it amounts to ·06 between 0° and 2° N., whilst it is only ·01 between 9° and 10° N., now between 0° and 2° N. temperature has decreased nearly 2°, whilst between 9° and 10° N. it has increased to the same amount.

The isobars are irregular, and for the first time since October the highest pressure shows in the southern part of the square.

The plain wind arrows show that the N.E. trade has retreated 2° on the western and 4° on the eastern side of the square since May, also that it has grown weaker in force.

The dotted wind arrows show how much the S.E. trade has gained both in amount and force, backed up as we find it is by an in-rush of high pressure from the southward.

Isotherms of Sea and Air.—The isotherms of sea and air show that there has been an increase of temperature in the N. and decrease in the S. since May, so that now for the first time since November both are colder in the S. than in the N. The hottest air and water are now on the western side of the square in the neighbourhood of the lowest pressure.

Current Arrows.—The plain current arrows show that the westerly current between 0° and 4° N., which is due to the S.E. trade, has become more decided and stronger, but is still running a little to the northward of W., whilst that due to the N.E. trade only holds in a few 2° squares in the north-western corner of the square where the N.E. trade still prevails, it still runs a little to the southward of W. Between them comes the easterly, dotted-arrow, current, which inclines to the north-eastward into that corner of the square which has little or no wind, indicating how thoroughly it is a back-drift of water which has been heaped by the trades. It seems worthy of notice that the sea-temperature in the north-eastern corner of the square has increased 3° since May, which is no doubt caused by the appearance of the warm easterly current where there had been a south-westerly one.

The Admiralty Current Chart of the Atlantic Ocean says that in the summer and autumn months this easterly current extends as far as 53° W., and runs at a rate of 60 miles in 24 hours between 53° and 40° W., getting weaker as it comes to the eastward.

Remarks.

Wind.—Between 1° and 2° N. and 20° to 21° W. there were three or four heavy squalls from N.N.E., though the chart shows no surface wind from that direction; this looks like a downward rush from the upper current which abounds from N.E. at this season.*

There was a most terrific squall, with thunder, lightning, and rain, between 5° and 6° N. and 21° and 22° W. Between 8° and 9° N. and 23° to 24° W., a ship lost her top-gallant masts in a heavy squall.

Clouds.—"Cir. from N.E., wind S.E." is now a very common entry;

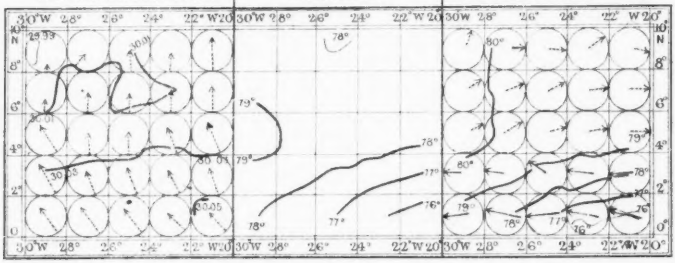
* These squalls were experienced by the same ship on the same day (June 9th).

JULY.

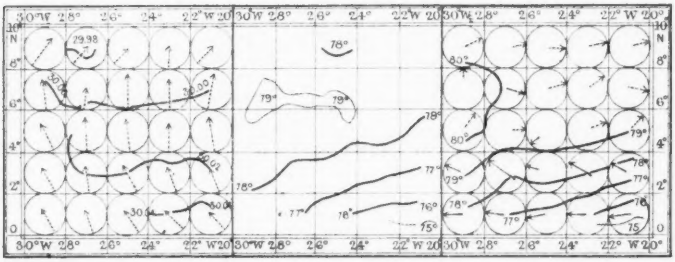
ISOBARS FOR EACH .02 OF AN INCH AND PREVAILING WINDS.* +

ISOTHERMS OF AIR FOR EACH DEGREE FAHRENHEIT.

ISOTHERMS OF SEA FOR EACH DEGREE FAHT AND PREVAILING CURRENTS† ‡



AUGUST



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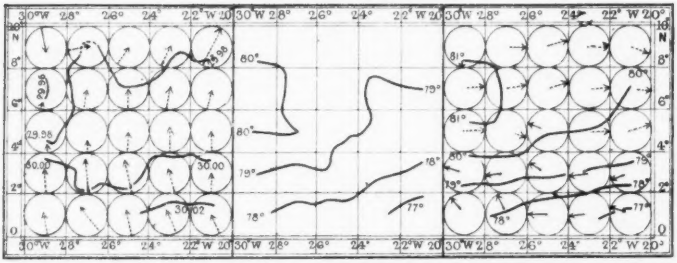

NOTE. *When the Isobars or Isotherms are deduced from the data of 1° squares they are represented by a faint continuous line. Broken lines merely connect the different parts of an Isobar or Isotherm when the data does not authorize its being drawn.*

* *Each arrow flies with the most frequent wind of its square. Its length shows the mean force up to 5 of Beaufort's scale, and is proportional to the rate per hour at which the wind would drive Beaufort's Ship Nine miles an hour (force 5) extending across the circle.*

\+ *Northerly winds and Westerly currents have continuous, whilst Southerly winds and Easterly currents have dotted arrows.*

‡ *The length of the current arrows is proportional to the rate in 24 hours. 50 miles extending across the circle.*

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whereas during the northern winter "Cir. from S.E., wind N.E." was a frequent remark.

Currents.—The remarks on currents show that much easterly current was experienced between 4° and 7° N. Also that the westerly current is frequently very strong near the Equator; from 0° to 3° N. it *averages* nearly 30′ in the 24 hours.

Natural History.—A beautiful ringdove was seen between 4° and 5° N. Dragon-flies, butterflies, and a cloud of insects called "Mosquito Hawks," between 6° and 7° N., and a swallow between 7° and 8° N. Locusts and butterflies between 9° and 10° N.

These seem to have been brought off the land by the tornadoes which blow from the eastward during the commencement of the rains.

Best route across the Equator.—In square 39, the strongest winds are still in the western half of the square, especially to the southward of 16° N.; on the eastern side of the square there is much light north-westerly wind between 16° and 18° N.

Considering the strong westerly current near the Equator, and that southerly winds extend so very far north, we are not inclined to recommend a westerly crossing to outward bounders in June, especially when we consider that the wind is frequently very far south near the American land in this month. Outward-bounders should stand boldly to the eastward with the southerly wind and easterly current, crossing the Equator well to the eastward. Homeward-bounders would probably do best by crossing the parallel of 6° N. in about 26° W.

July.

Isobars and Wind Arrows.—The isobars show a decided increase of pressure since June, and the barometer is at its highest point for the year. The mean for the square is 30·023. The highest, 30·069, is in its south-eastern 1° sub-square, whilst the lowest, 29·982, is in its north-western corner.

The increase of pressure is irregularly distributed, for whilst it averages more than ·04 in the southern half of the square, it does not average ·01 between 7° and 10° N. Where the pressure has increased so rapidly, the temperature of sea and air has decreased nearly 2° Fahr.

Plain wind arrows have disappeared from the square, and southerly winds prevail, though it will be noticed that they are very weak in the north-western corner of the square where the N.E. wind was prevailing in June, and where it always blew with so much more force than in other parts of the square.

Isotherms of Sea and Air.—The isotherms of sea and air have taken a very decided shape. They advance at the rate of about 1° Fahr. for each degree of latitude into the south-eastern corner of the square, until they come to 4° N., where they suddenly stop, and those for 79° of air, and 80° of sea, range round an area on the western side of the square.

Current Arrows.—The plain current arrows show that there is a very strong westerly current from 0° to 4° N., between 1° and 2° N., 63 per

cent. of all currents are north-westerly, at an *average* speed of 40′ in the 24 hours!

To the northward of 4° N. the dotted current arrows show that there is a prevailing easterly current, and we have already remarked that in latitude 4° N., which is along the line of contact between easterly and westerly currents, the change of temperature in air and sea ceases.

To the northward of 4° N., where the prevailing current changes from W. to E., the prevailing south-easterly wind becomes more southerly, and to the northward of 6° it is S.

Remarks.

Wind.—The southerly wind frequently blows with a force of 7 in various parts of the square.

Between 7° and 8° N. there was a very heavy squall from N.N.E. force 9.

Between 8° and 10° N. there are three entries of wind S.W. 8, also hard puffs from S.W., with constant heavy rain.

Between 8° and 10° N., the southern limit of the N.E. trade was met with five times, all in the early part of the month, and nearly all on the western side of the square.

Weather.—Mist is now most common over the cold water in the southern part of the square.

Clouds.—Upper clouds are still frequently from N.E. whilst the wind is S.E., there are also some cases even in the southern part of the square when the upper clouds were from the south-westward, when the wind was south-easterly.

Currents.—Between 4° and 5° N. are the following remarks:—"Sea very rough and turbulent." "Sea breaking like boiling water." "Ship on the edge of two currents, one going E. the other N.W."

Natural History.—The only allusion to creatures from the land was between 5° and 6° N. "Land birds, like hawks, flying to the north-eastward." As land birds are generally most ready to settle on ships, it is probable that those were sea birds; if so, there were none seen during July.

Sperm and other whales, grampuses, and black fish were seen. Between 8° and 9° N. we have "water covered with porpoises and bottle-noses, lying perfectly still." So perhaps they like the easterly current. Fish and sea birds were abundant. Stormy petrels were abundant to the southward, but not mentioned to the northward of 6° N. So perhaps they find suitable food in the cool westerly current.

Best Route across the Equator.—The western half of square 39 has the strongest winds, whilst they are strongest in the eastern half of SQUARE 3. Off Cape St. Roque there is a good deal of southerly wind in July. Considering the large amount of south-easterly wind and very strong westerly current to the southward of 4° N. in SQUARE 3, it seems right that outward bounders should be well to the eastward, say in 20° W. or probably several degrees further to the *eastward*, before going to the southward of 6° N., for in July ships bound to the

southward should not cross the equator to the westward of 25° W., on account of the southerly winds near St. Roque.

Good outward passages have been made in July, by passing to the eastward of the Cape Verde Islands.

Homeward bounders will do well to pass the parallel of 10° N. in 25° W.

August.

Isobars and Wind Arrows.—The isobars show a decided decrease in pressure since July.

The decrease of pressure has been slightly more, whilst the decrease of temperature has been less, in the northern than in the southern half of the square.

All prevailing winds are still southerly, and they have generally freshened since July, especially between 4° and 8° N.; from 8° to 10° N., the winds are more south-westerly than in July. The gradual curve in the direction of the prevailing wind as it passes from S. to N. is very marked.

Isotherms of Air and Sea.—The isotherms of air and sea are very similar to those of July, they have all advanced about a degree further to the northward, causing a slight fall in the mean temperature of the square; no doubt the result of the influx of cooler air and water from the southward, which has not yet been checked by the sun's southern progress.

The coldest air and sea (74°·4) experienced in the southern part of the square, shows in its south-eastern corner in August.

Current Arrows.—The currents of August are very similar to those of July, there is however a decided decrease in the force of the westerly current near the equator. We have the same sudden check in the change of temperature as in July, only it takes place about 1° further N., and we find by consulting the charts of 1° sub-squares that the prevailing westerly current does lie a little further N. in August than in July.

Remarks.

Wind.—Between 5° and 6° N., about 5 per cent. of the winds were force 7 from the southward. Between 6° and 10° N., about 2 per cent. of the winds were force 7 from the south-westward. Between 9° and 10° N., three south-westerly winds had a force of 8 and one of 9.

Weather.—There was very little thunder or lightning. Mist and dew were much more abundant over the cold water near the Equator than elsewhere.

Clouds.—Clouds were still frequent from the N.E. whilst the wind was S.E., though there is also great confusion in their motion at times.

Currents.—Ripplings are very general throughout the square.

Natural History.—No mention is made of seeing any land bird or insect in August. Whales were seen twice, one small one between the equator and 1° N. was going to the south-westward. Between

1° and 2° N., there was a shoal of grampuses going to the southward, where also many black fish were once seen.

Between 0° and 1° N., four strange looking fish were seen swimming about a ship for some time, they were red, had their fins on their heads, were about $2\frac{1}{2}$ feet long and a foot broad.*

Various.—There were 27 entries of falling stars, of these 7 were in 1857, and 6 in 1860.

Best Route across the Equator.—In square 39 the western half has the strongest north-easterly and south-easterly winds, whilst the eastern half has the strongest and most abundant north-westerly and south-westerly winds. SQUARE 3 has very little difference in direction and force of wind depending on longitude. Near Cape St. Roque the winds are still unfavourable.

It would seem well for the outward bounder to come to the southward on the western side of the Cape Verde Islands, and to stand boldly to the south-eastward with the south-westerly winds which will be first met with, bearing in mind that to the southward of 5° N., the wind will draw south-easterly, and the current strong to the westward, so that it would be well to be to the eastward of 20° W. before crossing the parallel of 5° N. Homeward bounders would do well to go to the northward in about 25° W., or even further W., as the winds in the western half of square 39 are stronger and more easterly than those in the eastern.

SEPTEMBER.

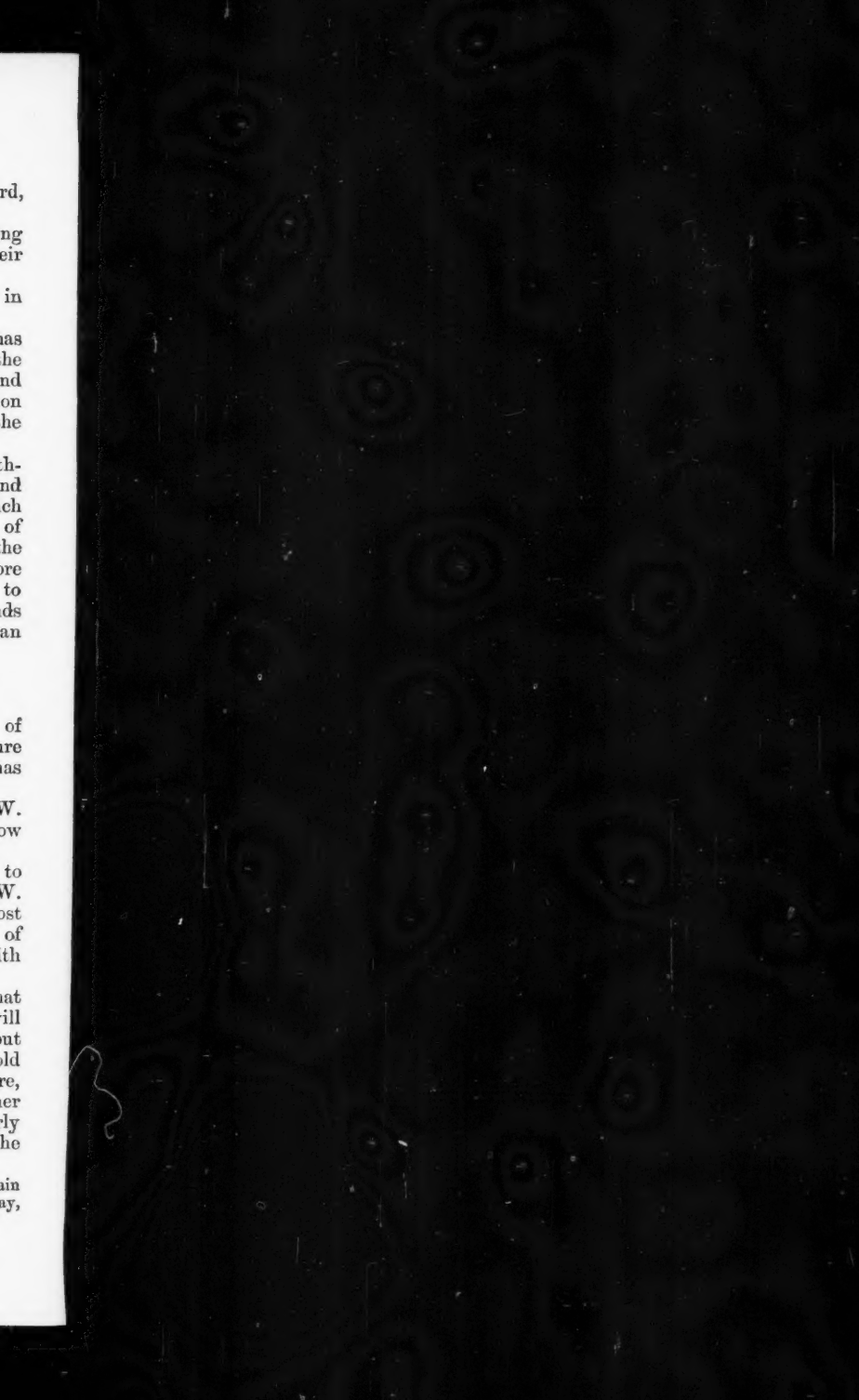
Isobars and Wind Arrows.—The isobars show a decided decrease of nearly ·02 in the pressure since August. The decrease of pressure seems to be very evenly distributed throughout the square. It has been greatest between 3° and 5° N.

There is only one plain northerly wind arrow, which is in the N.W. corner of the square, and it will be seen that a plain current arrow shows in the same 2° square.

The dotted southerly wind arrows are very similar in direction to those of August, changing gradually from S.E. in the southern to S.W. in the northern part of the square; but they have very decidedly lost in force to the northward of 4° N., especially on the western side of the square, where, it will be remembered, the N.E. trade comes in with the greatest force.

Isotherms of Air and Sea.—The isotherms of air and sea show that the temperature has increased nearly a degree since August. It will be remembered that, in August, temperature had decreased, but now, the southern progress of the sun has checked the influx of cold brought in by the southerly winds, and the isotherms are, as it were, backing to the south-eastward, each one being about a degree further to the southward than it was in August. The stronger southerly winds on the eastern side of the square lift the eastern ends of the

* This remark is from the log of the ship "Ingleborough" of Liverpool, Captain James Robert Rea, which was kept by the mate, W. H. Tiverton. Dated Friday, August 17th, 1855.

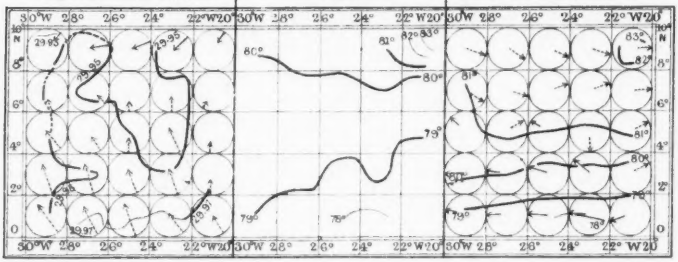


OCTOBER.

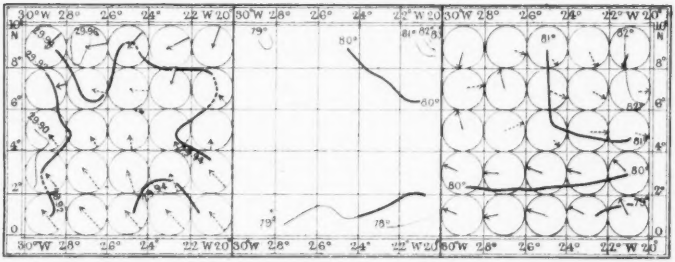
ISOBARS FOR EACH ·02 OF AN INCH AND PREVAILING WINDS.* †

ISOTHERMS OF AIR FOR EACH DEGREE FAHRENHEIT.

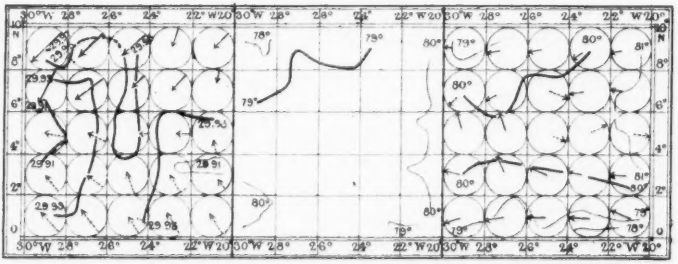
ISOTHERMS OF SEA FOR EACH DEGREE FAH.T AND PREVAILING CURRENTS.† ‡



NOVEMBER



DECEMBER.



NOTE When the Isobars or Isotherms are deduced from the data of 1° squares they are represented by a faint continuous line. Broken lines merely connect the different parts of an Isobar or Isotherm when the data does not authorize its being drawn.

* Each arrow flies with the most frequent wind of its square. Its length shows the mean force up to 5 of Beaufort's scale, and is proportional to the rate per hour at which the wind would drive Beaufort's Ship. Nine miles an hour (force 5) extending across the circle.

† Northerly winds and Westerly currents have continuous whilst Southerly winds and Easterly currents have dotted arrows.

‡ The length of the current arrows is proportional to the rate in 24 hours 50 miles extending across the circle.

J. Jobbins

isobars to the northward, just as the stronger northerly winds of March drooped their western ends to the southward.

Current Arrows.—The currents of September are very similar to those of August, the prevailing westerly current near the equator, has again lost somewhat in force. The easterly current is not so northerly as it was in August. The increase in sea and air temperature again progresses from the S.E. to the N.W., stopping after passing into the easterly current.

Remarks.

Wind.—Between the equator and 4° N. there were several south-easterly winds, having a force of 7.

Between 5° and 6° N. there was the largest percentage of winds force 7, they were chiefly from the south-westward.

Between 8° and 9° N. there was a N.E. squall; force 6; and a heavy easterly squall.

Between 9° and 10° N. south-westerly winds, force 7, were frequent, and sometimes with heavy gusts. There were also squalls from the same quarter, and a heavy northerly squall.

Between 8° and 9° N. the N.E. trade was twice experienced, about the 28th of the month.

Weather.—Coming from the southward, lightning was first seen between 4° and 5° N., where the easterly and westerly currents of water meet.

Clouds.—Upper clouds were most frequently seen coming from the north-eastward.

Natural History.—Between 4° and 5° N. a bird was seen, with a bill like a snipe and feathered like a plover.

Between 7° and 8° N. a martin, a swallow, and a hawk were seen.

Between 9° and 10° N. swallows and two other small land birds, butterflies and dragon flies, were seen.

Here we see that land birds and insects show themselves again in the northern part of the square, where the north-easterly wind shows itself towards the end of the month. They are probably brought off the land by the tornadoes.

No whales, grampuses, or black-fish were seen; porpoises were frequent, between 8° and 9° N.

Various.—"4 A.M., between 8° and 9° N., passed through a strip of water, as white as snow, stretching E. and W. as far as could be seen, and about 20 yards broad; the rest of the sea very dark, and not at all luminous."

Best Route across the Equator.—In square 39, the strongest winds are on the western side of the square, so that it seems best for the *outward bounder* to come to the southward on the western side of the Cape Verdes, and to stand boldly to the south-eastward when he gets the southerly winds and easterly current, tacking to the south-westward as the wind draws south-easterly, always remembering that there is a strong westerly current to the southward of 4° N. The wind is still very southerly near the land in the neighbourhood of Cape St. Roque, so that ships should not aim to cross the line far to the westward.

Homeward bounders would do well to go to the northward in about 25° W., or, at any rate, to be as far W. as 25° W. when in 10° N.

October.

Isobars and Wind Arrows.—The isobars of October show that there has been a general decrease of about ·04 in the pressure since September. This is the greatest decrease for any month in the year. On analyzing it, we find that it amounts to nearly ·06 between 0° and 3° N., whilst it is not quite ·03 between 7° and 10° N., indicating how the southern progress of the N.E. trade has checked the decrease in the north.

The plain wind arrows show that the N.E. trade appears in the northern part of the square, though it is very light and easterly.

The dotted wind arrows show that the southerly wind has retreated 2° to the southward, and decreased in force since September.

Isotherms of Air and Sea.—The isotherms of air and sea show that both have increased in temperature nearly 1° Fahr., since September. In both cases the increase has been greatest in the southern part of the square, where the air and water are coming in after having been under the influence of a vertical sun. The north-eastern corner of the square is an exception; it seems to be specially heated by the influx of easterly wind from Africa.

Current Arrows.—The plain current arrows show that westerly currents still prevail in the southern part of the square, and extend a little further N. than they did in September, but their speed is not so great.

The dotted arrows indicate that easterly currents still prevail in the northern part of the square, but their speed is not so great; hence we find that both winds and currents have become weaker since September.

Remarks.

Wind.—Between the equator and 6° N. there were several entries of wind from S.E; force 7.

Between 6° and 10° N. there were several severe squalls, but scarcely any steady winds of a force of 7. There were many severe north-easterly squalls, some extending as far S. as 4° N.

Between 1° and 2° N. there was a tremendous squall, lasting half-an-hour, with extremely heavy rain for 3 hours.

The N.E. trade is remarked on as being once met with between 6° and 7° N.; five times between 8° and 9° N.; and three times between 9° and 10° N.

Between 9° and 10° N., on the 19th, 1864, a very heavy gale, force 10, was experienced. The Captain says, "I never felt such a determined force of wind, lasting so long, about this latitude. It blew hardest from S. and S.W., lasting 3½ hours." This gale may have been related to a West India hurricane.

Weather.—Lightning was again first seen at the meeting of the two currents of water. From 3° to 8° N. it was most frequently seen to the northward, and from 8° to 10° N. to the southward.

Clouds.—Upper clouds were most frequently seen moving from the

south-eastward, though there was still a large percentage from the north-eastward.

Natural History.—Swallows accompanied ships as far S. as between 3° and 4° N. They abounded between 6° and 10° N., as well as other land birds and insects. The following entry gives an idea of their number:—"Between 9° and 10° N. an owl, say thirty martins, a few butterflies, and dragon flies about; wind, E.N.E."

In the N.E. corner of the square is the following entry:—"Strong smell of land," although it is 250 miles off. In the same part, the temperature of the air has gone up 2°·7 since September, and it is remarkably dry, so that, at this great distance, we find several evidences of the tornadoes which blow from the land in this month.

Whales were seen between 2° and 3° N., and several between 6° and 8° N.; all the latter moving to the northward.

The sea abounded with jelly fish, &c., from the equator to 6° N. Stormy petrels were very abundant between 5° and 7° N.

Various.—Falling stars were noted 23 times. They were very abundant in 1859 and 1866.

An earthquake was experienced, near St. Paul's Rocks, at 11·30 p.m., 19th, 1859. It lasted about 3 seconds. The ship felt as if grating over rocks; the helmsman felt the wheel shake in his hand. The captain was on deck at the time and can vouch for the truth of the statement. We have already remarked on one in the same place, in January of the same year.

Best Route across the Equator.—Square 39 has decidedly stronger winds in the western than in the eastern half of the square.

Square 3 has lighter winds on the eastern than on the western side of the square, and the currents are not so strong as in September.

Square 303 has a prevailing S.E. by E. wind, with sometimes a spirt of north-easterly wind near the land.

Hence it seems well for the outward bounder to pass to the westward of the Cape Verde Islands, and to stand boldly to the south-eastward, with the southerly wind and easterly current, until the wind will allow of a fair amount of southing on the port tack, when she may stand boldly to the south-westward, and, if necessary, cross the equator as far west as 28° W.

Homeward bounders should go to the northward on the western side of the square.

November.

Isobars and Wind Arrows.—The isobars of November show that there has been an average decrease of about ·02 in the pressure since October, but we find that it is chiefly in the southern part of the square; for instance, between 9° and 10° N. it has not changed, whilst between 0° and 1° N. it has decreased nearly ·04. Here, as in October, we have the effect of the N.E. trade pressing to the southward in the northern part of the square. For the first time since May the highest pressure is in the northern part of the square. The isobars are also crowded in the north-western corner of the square.

The plain wind arrows show that the N.E. trade has become more frequent in the northern part of the square, where it has also gained in strength. It is still very easterly, which contrasts remarkably with its direction from February to May, when it is very northerly, especially on the eastern side of the square.

The dotted wind arrows show that the S.E. trade has retreated and lost in force, especially between 3° and 5° N., as shown by the chart of 1° sub-squares.

Isotherms of Air and Sea.—The isotherms of air and sea still run in similar directions, and the sea keeps nearly 1° warmer than the air. Both continue to show the highest temperature in the north-eastern corner of the square. This is a singular case of the wind blowing from greater heat towards greater cold; it is accompanied by a great difference between dry and damp bulbs, as also by the appearance of insects. The heat in the N.E. corner of SQUARE 3 is increased by the easterly current still prevailing there. In December it is driven further south by the influx of a westerly current.

Current Arrows.—The plain current arrows indicate that a westerly current is again showing in the northern part of the square, whilst it still prevails up to 4° N., though not quite so strong as in October.

The dotted current arrows show that easterly currents still prevail from 4° to 10° N., but that they are not so strong as in October. It will be noticed that in the north-eastern part of the square the prevailing current is more to the southward of E. than it had been in previous months, as if it began to feel the influence of the freshening northerly wind.

Remarks.

Wind.—Between the Equator and 6° N. there are still several entries of south-easterly wind having a force of 7: whilst from 7° to 10° N. those from N.E. are most frequent. Of the seventeen entries, five were south-easterly and twelve north-easterly. Between 9° and 10° N. very heavy squalls were experienced.

Between 8° and 9° N. we find "Wind variable, sometimes very hot, at others very cold." This is interesting in connection with the high temperature in the north-eastern corner of the square.

Weather.—Lightning has greatly increased since October, it is most frequently seen in the northern part of the square; from 5° to 8° N. it is chiefly seen on some northerly bearing, but from 8° to 10° N. on some southerly bearing. It was most abundant and awful between 6° and 8° N., with stifling weather.

Clouds.—Upper clouds from the north-eastward have greatly decreased since October, whilst those from the south-westward have increased. Those from the south-eastward still greatly preponderate.

Natural History.—An owl, a teal, and some swallows were seen between 3° and 4° N., between 4° and 6° N. there were several land birds. Some captains remark that they had followed their ships from the northward. Between 6° and 8° N. butterflies and a moth were seen, as well as land birds.

Whales, blackfish, and porpoises, as well as fish, birds, and

medusæ, abounded between 4° and 6° N., which looks as if the verge of the two currents was favourable to animal life.

Various.—Falling stars.—There are thirty-six entries of falling stars, the most abundant seem to have been between the 9th and 10th, 1855, and after midnight of the 14th, 1869.

Best route across the Equator.—Square 39 has decidedly stronger winds on its western than on its eastern side, especially between 14° and 16° N., for in the eastern half of that zone we find 17 per cent. of calms against none in the western half.

Square 3 has the lightest winds in its eastern half.

Square 303 has a good deal of north-easterly wind near the South American coast in November, so that it seems safe to stand boldly to the southward, after passing to the westward of the Cape Verdes, and on getting the southerly wind, to take the tack which gives the most southing.

December.

Isobars and Wind Arrows.—The isobars of December resemble those of November. There is scarcely any change in the mean pressure of the whole square since November, for there has been an increase in its northern and decrease in its southern half. The greatest increase is in the north-western corner of the square, and the greatest decrease in the south-eastern, so that now the highest pressure is very decidedly in the northern part of the square. The isobars are closest in the north-western corner of the square where the N.E. wind is strongest.

The plain wind arrows show that the N.E. trade has worked its way down to 6° N., and increased in force, especially in the north-western corner of the square.

The dotted wind arrows show that the prevailing wind is nearly E. between 4° and 6° N., in which zone the two trades seem to meet and combine to form a stronger wind than that which prevailed in November.

Isotherms of Air and Sea.—Here we find a lower temperature coming into the north-western part of the square where the N.E. trade is so fresh; in the case of the air the lowest temperature of the square is there. The south-westerly trend of the isotherms in the northern part of the square, and the north-westerly trend of those in the southern, indicate that they are the result of the two trades, and inclining to the southward or northward with their strongest winds. The hottest air and water now show on the eastern side, instead of in the north-eastern corner, of the square.

Current Arrows.—The plain current arrows indicate that where the N.E. trade has increased, a westerly current has set in, which inclines to the southward.

The equatorial westerly current, which is a constant result of the S.E. trade, has increased in force and inclines to the northward, especially on the western side of the square.

The dotted current arrows show that the easterly current has reduced very much in amount since November, but that it still exists on the

eastern side of the square where the sea is hottest; it inclines to the southward.

Remarks.

Wind.—We have twelve entries of steady winds amounting to force 7. Of these four were south-easterly, two easterly, and six north-easterly.

Squalls were not so abundant in December as in November: they were most frequent from the south-eastward and eastward.

Weather.—Lightning was most frequently seen to the northward between 1° and 6° N., whilst from 7° to 9° N. it was much the most frequently seen to the southward.

Clouds.—There is a great increase in the percentage of upper clouds from the north-eastward, whilst that of others has decreased. This is not in accordance with the experience of November or January.

Natural History.—A small brown owl was caught between 3° and 4° N.

Four butterflies and a land bird were seen between 5° and 7° N.

Whales were seen between 3° and 4° N. Grampuses between 4° and 8° N.

Black fish between 1° and 9° N. Porpoises between 4° and 8° N.

Various.—Falling stars were reported sixteen times. The most numerous were on the 2nd, 1839; the 12th, 1855, very abundant; the 11th and 12th, 1857.

Brown dust was seen on the sails between 1° and 9° N.

Best Route across the Equator.—In square 39 there are decidedly stronger winds on the western than on the eastern side of the square. There are 15 per cent. of calms between 14° and 16° N. on the eastern side, whilst, in the same zone, there are none on the western. On the western side there is a large per centage of south-easterly or easterly winds, *especially in the northern part of the square*, where it amounts to 40 *per cent.*! This fact is supported by the remarks in December, which say that the N.E. trade has been more like the S.E.

In SQUARE 3 the winds on the western side are also very decidedly the strongest, whilst in square 303 nearly all winds are to the eastward of S.E., so that ships need not fear crossing the equator well to the westward.

CONCLUSION.

We have now given a slight history of a square of the sea, which, during the year, is twice traversed by a zone of high temperature and an accompanying area of low pressure, into which opposing winds are drawn. The amount and direction of each wind seems to be very much modified by the temperature and position of its source. The temperature of course, to a great extent, depends on the declination of the sun; but the position of the source of each wind depends upon the relative positions of land and sea.

By consulting Buchan's isobaric lines* we see a picture of the areas

* "The Mean Pressure of the Atmosphere, and the Prevailing Winds, over the Globe, for the Months and for the Year." By Alexander Buchan, M.A., F.R.S.E. "Transactions of the Royal Society," Edinburgh, vol. xxv.

of high pressure which lie on the polar sides of the trade winds. They are given on Diagram 1, and marked A and B. These areas are supposed to supply the air of the trade winds, and it will be seen that SQUARE 3 has the southern one bearing to the south-eastward, so that it gets the full force of the S.E. trade, never entirely losing the prevailing south-easterly wind and westerly current caused by that wind, but the northern area of high pressure is to the northward, or rather north-westward, of SQUARE 3, whilst the coast of Africa is very near the north-eastern corner of the square, so that a large part of its area is, as it were, under the lee of Africa, and the full swing of the N.E. trade is only felt in its north-western corner. This is beautifully shown by the direction and relative length of the arrows of prevailing wind from December to June. This opinion is fully borne out by the fact that the north-eastern coast of South America, which is to the south-westward of the northern area of high pressure, gets a N.E. wind as far down as 3°, or even 4° S. during the strength of the N.E. trade, when SQUARE 3 has a S.E. wind up to 2° N.; hence we find that the sun creates a low pressure in the doldrum, and the area of high pressure in either hemisphere which is most convenient and has not heated land in the way, supplies its demand.

The northern part of SQUARE 3 only gets prevailing easterly winds during the short time when the pressure over the neighbouring African land seems to be greater than that over the sea to the westward and south-westward of it. It will be remembered that October, when the easterly wind sets in, is one of the hottest months of the year in SQUARE 3, and that since September there has been the greatest monthly fall in the barometer, especially in the southern part of the square, which may account for the sudden in-rush of hot air, birds, and insects from the land into the north-eastern corner of the square, where the land is even smelt, though more than 250 miles off!

I will now by your permission say a few words on certain facts which have struck me whilst working at the data of SQUARE 3.

1st. We find that during the northern winter and spring, when the N.E. trade is pressing its way to the southward as a body of cold air, more upper clouds are seen to be moving to the northward, whilst during the southern cold season, when the southerly wind is pressing its way to the northward, and crosses the Equator as a mass of comparatively cold air, more upper cloud is seen to be moving to the southward.

This looks as if the air which rises in the doldrums had freer egress towards that pole which is experiencing winter. If this be the case, which we shall be better able to decide after all the remarks for SQUARE 3 have been systematically worked up, it seems clear that any cause, such as a remarkable increase of temperature in one hemisphere, or decrease in the other, which tends to give freer course in a certain direction to the upper current, and thereby to increase the amount of air in that area of high pressure which lies on the polar side of a trade wind, will most probably increase the force of the various winds flowing from it. For instance, if during last winter any cause existed which threw a larger body of air than usual into

this upper current travelling northward from the doldrum, then we might expect to find a higher pressure than usual in about 30° N., where this upper current seems to settle down, and stronger westerly winds to the northward of that latitude. For the higher the pressure near the Azores, in comparison with the low pressure which prevails over the Atlantic to the northward of them, the stronger will be the westerly winds between these two pressures. This supports the idea which I have heard expressed by Captain Evans, that we may have to look to the doldrums for the causes of our weather changes.

2ndly. We find that the highest pressure in SQUARE 3 takes place in July, and it is after this time that the West India hurricanes commence, hence, just as two people are needed to make a quarrel (or two high tempers), so are two high pressures required to form a hurricane. Here we have a high pressure on the southern side of the doldrum, and we know that there is always one to the northward of it; we also know that the southern progress of the sun in July is drawing with it the doldrum, or zone of lowest pressure, and the prevailing winds on each side of it, so that where southerly winds have been, northerly winds are coming, and it seems to be the collision between those winds which gives the first start to the West India hurricanes. The large amount of heat and moisture in the air, at this season, is no doubt a great additional reason for them. It seems worthy of remark that lines drawn to the north-westward and south-westward from the areas of high pressure, A and B, which supply the air for the two trades, would cross in about that part of the sea where the West India hurricanes are bred. See such lines on diagram 1.

In paper, No. 13, published by the Meteorological Office, we have shown that the winter snow storms on the East Coast of America have a similar cause to the one given above for the West India hurricanes, viz., a high barometer over the American land, and another over the sea to the northward of the N.E. trade, with a lower barometer and warm moist air over the Gulf Stream which runs between the two high pressures just named. Mr. Meldrum finds that the Mauritius hurricanes arise from a like disposition of pressure.

3rdly. In SQUARE 3 there seems to be a much smaller difference of pressure to a given distance for a given amount of wind than there is over the British Islands. For instance, our diagrams seldom show more than a difference of ·01 inch to 50 miles, with an average wind force of 3 or 4 of Beaufort's scale, whilst such a difference would be an indication of much less wind in England.

4thly. It will be seen that although the trade winds which produce the westerly currents of water are chiefly north-easterly and south-easterly, the currents themselves are chiefly westerly. Now it is known that the air composing the trades which meet in the doldrums, rises, and passes away as an upper current, but the water which they drive before them, as well as that which falls so abundantly in the doldrums as rain, cannot rise like the air, excepting the very small quantity lifted by evaporation in this cloudy rainy part, so that it must be heaped and form a ridge of water in the doldrums, which ridge would naturally divert the water flowing towards it into a more

westerly direction than that of the air which drove it. From this ridge the easterly current, so frequently mentioned in this paper, seems to run as a back-drift, when the pressure of a following wind ceases. The outline of the Coast of Africa, considered in connection with the north-westerly current caused by the S.E. trade, accounts for the back-drift into the Gulf of Guinea; for the tendency of the above named current is to draw water out of the Gulf, just as blowing at right angles across the mouth of a tube full of liquid draws it out, the result being that the water in the Gulf is at a lower level than that to the westward of it, where the tendency of the two trades is to heap water; consequently, as soon as the two currents meet in the calm of the doldrums, the water is free to act under the influence of gravitation only, and flows to the eastward into the Gulf of Guinea.*

In the last place let me call your attention again to the remarkable way in which the temperature of the sea continues about 1° Fahr. warmer than that of the air, a similar difference was noticed when working at the meteorology of the West Coast of South America. (See p. 17 of Official, No. 11, published by the Meteorological Office.)

I have now given you a hurried sketch of the work which is in hand in the Marine Department of the Meteorological Office; this work will, it is hoped, be as useful to the scientific man as to the navigator. The Committee of the Royal Society who manage the Meteorological Office, propose to publish monthly charts similar to the one now exhibited, which are to be accompanied by important extracts from logs relating to wind, weather, clouds, natural history, and physical phenomena of any kind.

May I be permitted to add that the way in which we find one class of observation supporting the evidence of another, seems to be an argument in favour of working up the various data together, instead of dividing them amongst different nations. For instance, in the north-eastern corner of SQUARE 3, in October, we have a great increase in the temperature of the air and sea, as well as in the dryness of the air; there is also a large number of land birds and insects, and a strong smell of land, all of which come with a prevailing easterly wind. These facts are, to a certain extent, related, and would lose force by being separated. The same remark is especially applicable to the sudden stop in the change of temperature of both air and sea, as we pass from the westerly to the easterly current of water in July, and other months.

I have found it difficult to convey a general idea of the work in so short a time, and beg to thank you for your kind attention.

* It seems quite clear that if the N.E. and S.E. trades draw the sea away from Africa, and if other water cannot come from the westward, there must somewhere be a back-drift to the eastward.

The large amount of current ripplings in SQUARE 3 seems to be caused by this diverting of the currents out of the directions in which the winds would drive them, if the drifts of the two trades did not meet and heap the water.

LECTURE.

Friday, March 28.

Major-General J. T. BOILEAU, R.E., F.R.S., in the Chair.

RIFLES AND RIFLING.

By Captain J. B. O'HEA, late 25th King's Own Borderers.

THE CHAIRMAN: Allow me to introduce to you my friend, Captain O'Hea. He is no novice in matters connected with rifles, and I have no doubt that he will give us both a very interesting and a very instructive lecture.

Captain O'HEA: After the years occupied by the late Special Sub-Committee in experiments with the object of obtaining for the nation the best military small-arm, and the elaborate Reports published on results of trials conducted under their superintendence, a paper on rifled arms may appear almost superfluous. However, esteeming a request from the Council of this Institution not only an honour but, to a certain extent, a command; and further, bearing in mind that nearly three years have gone by since the publication of the reports of the Special Committee—three years remarkable for improvements in breech-loading rifles (about sixty patents having been applied for during that time), and for the occurrence of a great continental war which afforded, I may say, the first practical test of the system; I have much pleasure in giving here, the information which I have derived from trials with various descriptions of this class of weapon.

In explanation of the title of my paper, "Rifles and Rifling," it may be well briefly to refer to the origin of the word and the weapon,—to define what a rifle really is, and what is meant by rifling.

With regard to the derivation of the word *rifle*, opinions vary much. It is stated by some, that the name comes from the Teut. word *Rijffelin*, a kind of whetstone with finely fluted surface (in the early rifles, the bore was channelled or fluted); others assert that it comes from the Danish word *riffel*, a chamber or groove; again it is said to be derived from an Anglo-Saxon word signifying to *rive* or *tear*, this last derivation having reference no doubt to the manner of forming the rifling. This difference of opinion clearly indicates the absence of definite knowledge of the origin of the word.

About the date and place of the origin of rifling, opinions are nearly

as conflicting. Notwithstanding the many statements hazarded on this point,—namely, that the rifle was invented at Vienna, in 1498; at Nuremberg, in 1520; in Denmark, in 1545,—I would, without any desire to be sceptical, remark that the origin and date of grooving or rifling barrels, like those of the invention of portable fire-arms, are, and must remain, matter of speculation. And I would venture merely to suggest, that the origin of straight rifling might, not without reason, be traced to the primitive mode of forming a polygonal bore, as in the earlier iron guns, by placing bars of iron together longitudinally, and binding them over. Some of these old arms are still to be found. From the specimens in existence, one thing appears pretty certain,—that, in Europe, rifling was first adopted as a means of facilitating loading from the muzzle, and the fluted grooves or lines (which, like the *Riffelin*, were straight), were simply intended as channels to drain off the fouling of previous discharges, and thus render loading less difficult.* The gunmaker of Nuremberg who has the doubtful credit of having been the first to cut these channels on a curve, is supposed to have done so by accident. I would observe that Dryden, in the fifth act, first scene, of his well-known play "Marriage-à-la-Mode," written prior to 1673, makes allusion to the rifle as a "delicate screwed gun"; and in 1672, P. Daniel, in his "Histoire de la Milice Française," refers to the invention as old. Be all this as it may, until Robins published his tract on "Rifled-barrel Pieces" in 1747, there is no trustworthy evidence to show that the real effect of spiral rifling on the flight of projectiles propelled by gunpowder, was understood.

I have no desire to inflict on this assembly a further or more detailed history of the rifle. I shall content myself with defining what the modern rifle is, its object, and results.

The word "rifle," in its general acceptation, means the arm complete; but, as most people know, the barrel gives the distinctive appellation.

A rifled barrel or tube is literally nothing more or less than a compound mechanical power, *i.e.*, a female screw—the nut through which a bolt (the projectile) is driven with more or less velocity, according to the power applied to it, and as the pitch and form of screw afford more or less facility for its transmission. This, whether the projectile be a perfect or imperfect sphere, a rifled cylinder for its whole length or only in part. In any case, the projectile becomes the male screw if, when passing through the bore or any part of it, its surface is made to conform in any way, or by any means, to the incline of rifling. Whether this conforming is effected by expansion at, or ramming down from, the muzzle, as in early rifles (and indeed in those used far into the present century); by expansion at the breech caused by ramming on a pillar on Colonel Thouvenin's plan, or by a cup or plug inserted at the base of the bullet; whether the projectile is made to conform to the

* A very similar pattern of rifling was manufactured in this country not many years ago—although for a different purpose. I allude to what was known as "scratched" rifling: this consisted in fluting or rifling shot barrels with straight lines along which the grains of shot were supposed to travel in passing up the bore, thus keeping the bulk of the charge well together It would be instructive to learn from some of the leading gun manufacturers what effect this system had on the birds.

pitch of rifling by means of a sabot, as in the Prussian gun, or by a jacket of leather, paper, or other material, or is compelled to follow the rifling by studs, grooves, ribs, &c.;—in every case where the surface of the projectile is made to rotate in the bore round its axis of progression, the projectile is the male, and the barrel, being the means, is the female screw.

The power, however, used in the rifle is not like that of the lever with the screw. I would remark here, that this mechanical means, the rifle barrel, is used with a power essentially unmechanical, inasmuch as when once that power, gunpowder, is put in action, it is not under control. All ordinary powers used in mechanics are capable of being controlled; but gunpowder once ignited, is, of course, to a great extent, unmanageable. It appears strange that, up to the present time, beyond the slight variation obtained by difference in the size of grain or the position of point of ignition in the charge, but little practical effort has been made to control, even to a limited extent, the combustion of gunpowder in fire-arms, or to apply judiciously and gradually to projectiles—according to different weights, and to the resistance offered to initial motion—the power stored up in the charge.

The subject of rifling may be divided into the pattern, or quality, of screw used; the pitch, or power, of screw used; the manner of manufacturing or forming the screw; and lastly, the effect which each pattern of rifling and degree of pitch has on the projectile with reference to the power applied to it,—*i.e.*, on velocity and vertical accuracy, and on the arm itself with reference to recoil, and wear and tear.

Benjamin Robins, in his tract on "Rifling," before alluded to, states that "the number of threads in each barrel are (*sic*) different accord-
" ing to the fancy of the workman, and the size of the barrel; and in
" like manner, the depth these channels or rifles are cut down to, is
" not regulated by any invariable rule, but differs according to the
" country where the work is performed or the caprice of the artificer."
At the present time, the pattern of rifling appears to be as much a matter of fancy, as were the number of threads and the depth of the channels in the time of Robins. An inspection of the valuable collection of rifles in this Institution, will bear out this assertion.

Nevertheless, the pattern of rifling may be divided into three, or at most four, distinct classes, namely:—(1), the ordinary land and groove pattern, of which there are many modifications, some of which possess special merit; (2), the elliptical, known as the Lancaster, system, which, although stated by Greener and others to be a modification of the two-groove rifling, is nevertheless a distinct pattern, inasmuch as the barrel is throughout a smooth-bore rifle, if I may thus express myself; and (3), the polygonal, formerly known as the angular pattern of rifling, and now styled the Whitworth. All other patterns appear to me to be either modifications or compounds of the above,—not even excepting the well-known and popular Henry, now the recognized rifle-barrel of our service, and to be met with in the hands of the most distinguished shots in the kingdom.

There is yet another system of rifling barrels, patented within the last two years, viz., "part" rifling; but, as it is applicable to all or any

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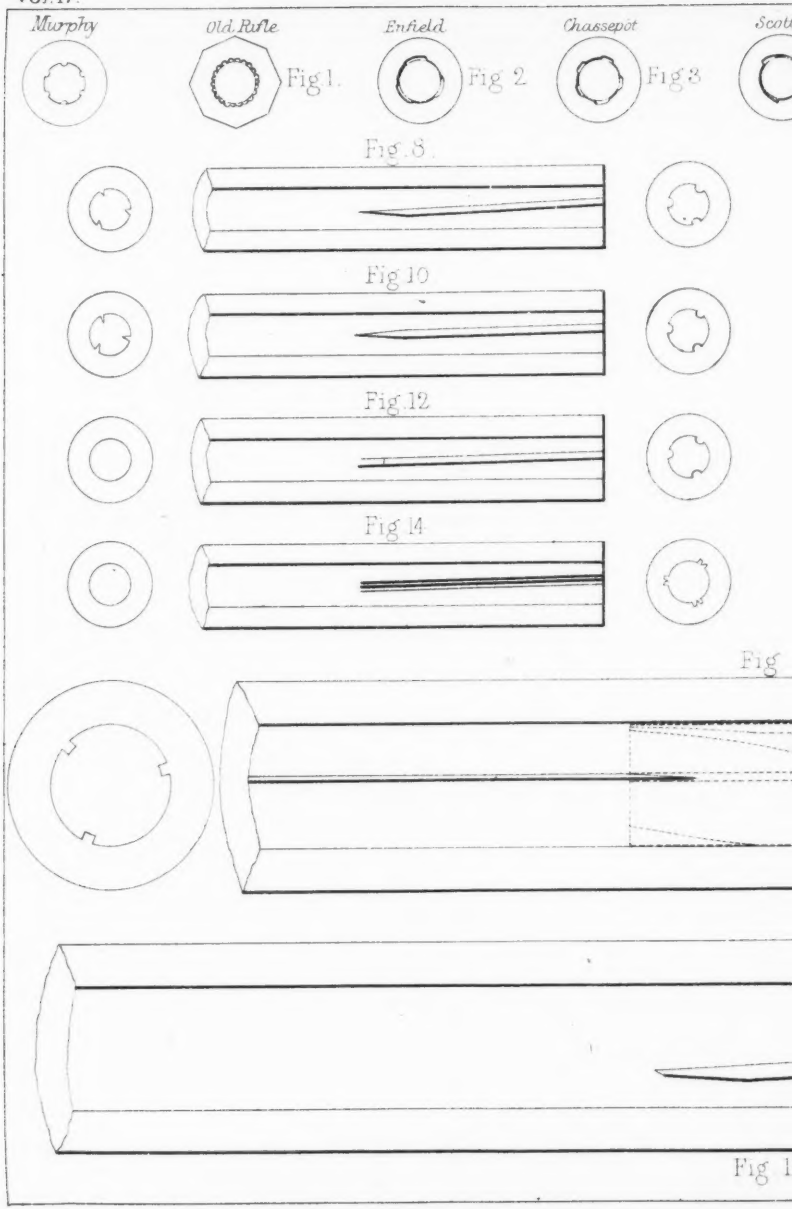
Murphy
Old Rifle
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Fig 1.
Fig 2.
Fig 3
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Fig 10
Fig 12
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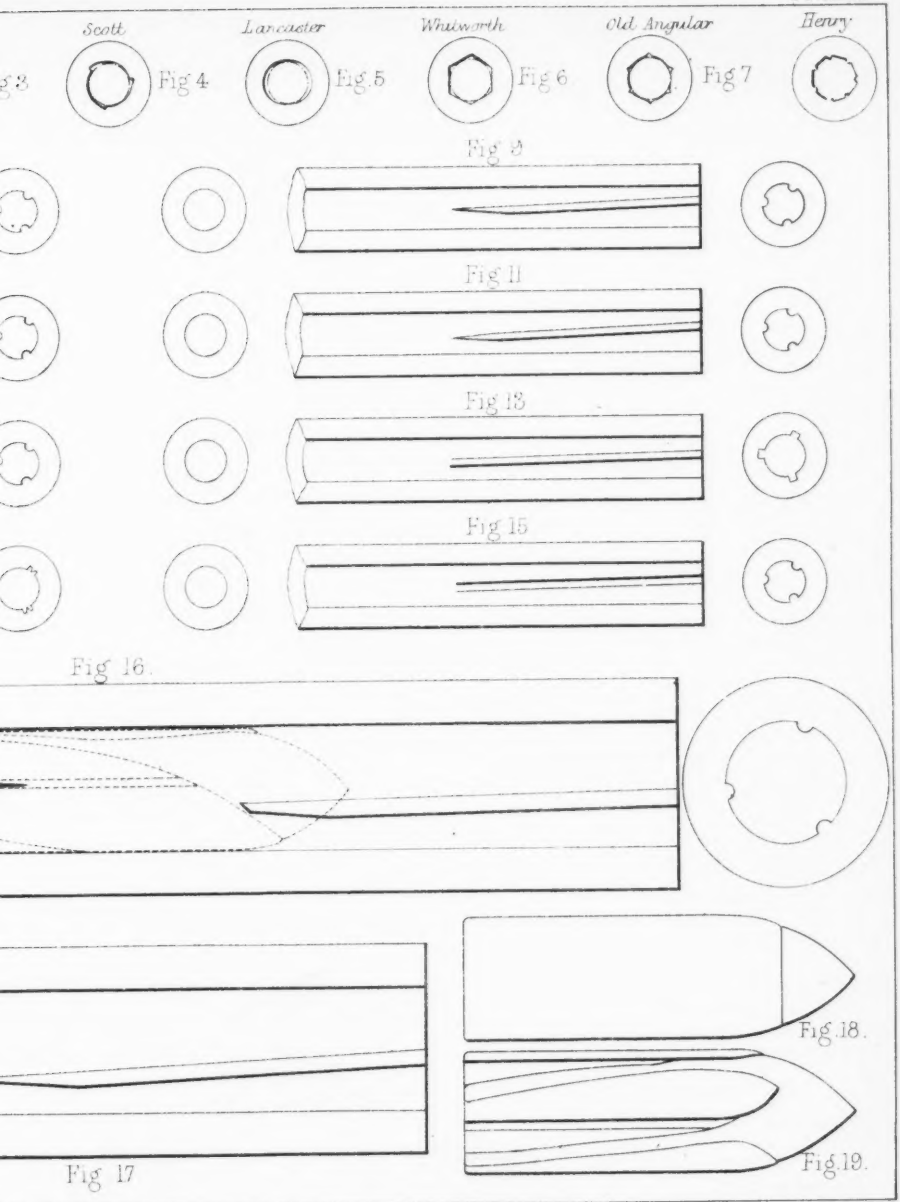
Fig
Fig 1


Scott
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Old Angular
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Fig 4
Fig 5
Fig 6
Fig 7
Fig 8
Fig 11
Fig 13
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Fig 16.
Fig 17
Fig 18.
Fig 19.

J Jobbins

pattern, I shall not describe it under this head. The system is altogether a novelty, as I shall explain presently.

Of the pattern I first named—the "land and groove"—I can say but little that you do not already know. It may not, however, be out of place to remark that the *angular* land and groove pattern, shown in Plate XXII, necessitates a large frictional area of resisting surface in the barrel and projectile:—the deeper and more angular the rifling, the larger the area of friction, which not only involves deformity of the surface of the bullet, but causes a certain unprofitable expenditure of powder, consequent on the increased frictional resistance. It is, therefore, obvious that the shallower and less angular rifling of this pattern is, the better: as, in addition to other advantages, the less will be the indentation of the surface of the bullet, the less then the alteration of the figure, and, as a consequence, the harder may be the material composing the bullet. I would name as examples of the severe land and groove pattern of rifling that known as Baker's rifle (see Plate, fig. 1), the original arm of our Rifle Brigade; of the finer kind, the Enfield (fig. 2), and the Chassepôt (fig. 3); and of the very finest pattern, the Metford, the high reputation of which affords the strongest proof of the value of fine rifling. The rib pattern is the land and groove in a different form; the land being narrow and, in some cases, shallow and non-angular, the groove wide. In this pattern, the narrower, shallower, and less angular the rib, the more efficient the rifling,—provided the projectile is composed of a material capable of being moulded to the shape of the bore. Another form of the rib pattern is what is termed segmental rifling, that is, the bore grooved in segments of a circle of much smaller circumference than that of the entire bore, the space or angle between the segments serving as a fine rib. This pattern approaches the fluted rifling used in early arms, the difference consisting only in the incline of rifling and the number of segments.

I would advert to ratchet rifling as another modification of the land and groove pattern, as it is a union of the angular rib and inclined plane (or segment). The most perfect modification of this form (fig. 4), is the invention of Captain Scott, R.N.; it has considerable merit in small arms, but, as it appears to me, will prove of still more value in large guns. I believe this is the only pattern of rifling for ordnance which not only compels rotation of projectile round the axis of progression, but, by the very effort of forward motion, combined with rotation, forces the shot to centre itself in the bore:—the importance of this it is unnecessary for me to point out.

The elliptical, or Lancaster pattern (originally, I believe, American) (fig. 5) necessitates a departure, not only from the rules that regulate the formation of the screw, but, to a certain extent, from strict mechanical principles; for not only is the bore smooth, but, in addition, the difference in the diameters across what, if more defined, would be called grooves and lands, is very slight, the difference between the major and the minor axis being ·005. Therefore, in order to prevent slipping of the projectile—which must be of soft metal—in its passage up the bore, it is necessary, not only that the pitch of rifling should

become quicker towards the muzzle, but that the bore should lessen somewhat in both diameters towards that point.

Although the practice of the Lancaster rifled small-arm in the hands of our Royal Engineers has given very high results, it appears to me that as the projectile has, while passing up the bore, to undergo a continual change of form, consequent on the increasing pitch of screw, the system cannot be considered, mechanically speaking, correct. Moreover, I believe I am not in error in stating that, in large guns rifled on the Lancaster system, an increasing spiral cannot be used. At the same time, while I feel compelled to remark that it is impossible to obtain even expansion from a barrel, the bore of which is an ellipse and the outer surface a circle, I feel bound, in justice to this pattern, to state that I have used a Lancaster double rifle with fair results, both with shot and bullet.

The polygonal, or Whitworth pattern, which is the old angular rifling in an improved form (see Plate, figs. 6, 7), is too well known to require description. The patentee, one of our greatest engineers, has gone far by his experiments to indicate the value of certain degrees of pitch and diameters of bore,—whether to decide the best pattern of rifling or not, is a matter on which opinions differ; and, above all, he has shown how an ancient pattern of rifling can, by proper manufacture and judicious management, be made to give exceptionally good results. But the Whitworth polygonal rifling is coarse, and when a cylindrical bullet is used, involves, as can be seen, considerable windage, which has to be provided against by wads or wrappings, &c.

The Reports of the Special Sub-Committee give an account of the Henry rifling which received the prize offered by the Secretary-of-State for War in 1868, for the best rifle. The rifling is polygonal, having a rib in each angle, which latter feature materially lessens the windage, thus securing an advantage over the simple polygonal pattern when a cylindro-conoidal bullet is used. (See Plate, fig. 7a.)

I would, however, mention two peculiarities connected with the Henry rifle barrel, of which the one may not be generally known—the other is inconveniently felt by those who use the Martini-Henry. Neither of these peculiarities, as far as I know, is particularised in the official reports on the arm. First. The hardened projectile used with the Henry rifling scarcely ever bears the mark of the rifling on the surface of the metal after being fired, certainly never on that portion of the bullet in front of the canelure, and very seldom on the narrow rim below the canelure. The only marks I have been able to trace on the large number of these bullets I have recovered in an almost uninjured state, were those caused by the plaiting on the neck of the case, and which were indented on the bullet by the choking. It is clear, therefore, that this projectile gets rotation principally by means of the wrapping or jacket upon it. The wrapping is also the chief means of preventing the gas escaping along the rifling; for in reality the Henry heptagonal rifling is not what may be termed fine,—it is peculiarly defined, and, as may be seen, there is considerable windage when the bullet is inserted naked in the bore. The fact, however, that the Henry projectile has scarcely any mark of rifling on its surface after it leaves the bore, somewhat lessens

resistance to progressive motion, and thereby gives it an advantage in after flight, as well as in penetration. Secondly. The other peculiarity to which I referred, and which I may say is now rather notorious, is the excessive recoil of the arm with which the Henry barrel is officially connected. This recoil cannot be entirely the result of resistance to the initial motion of the projectile, as that touches but lightly on the rifling; nor can it be altogether the result of its weight, one oz. of 480 grains (strange to say, it is weighed as if it were precious metal, by Troy weight); nor can it be ascribed altogether to the 85 grain powder-charge: but these, together with the peculiarly defined pattern of rifling and the sharp pitch (one turn in 18 inches), go far to account for it. This brings me to the subject of pitch. But before leaving the subject of pattern, I would remark that in rifling of every description (and in the polygonal patterns especially) a portion of the surface of the original cylinder—the true bore—is cut away; moreover, this is accomplished by an uncertain method and with a faulty instrument:—the more, therefore, of a true cylinder left uncut or unscraped away the better,—until a more perfect means of rifling is discovered.

Pitch in rifling is resistance to the direct progressive motion of the projectile through the bore. This resistance varies according to the incline as well as the pattern of rifling; for as the more defined the pattern the more the resistance, so the sharper the pitch, the greater the rotation of projectile round the axis of progression, and consequently the more difficult its initial and the slower its direct forward motion. Now, all else, save pitch of rifling, being equal, it is plain that the greater the initial resistance offered to the forward motion of the projectile, the greater the recoil; and I submit that, in after flight, the higher the rotation, the lower the velocity, and consequently the higher the curve of trajectory;—although the ultimate accuracy of direction may be not wholly unsatisfactory. It is not a matter for surprise, therefore, that the pitch of rifling has been the subject of experiments as numerous and curious as has the pattern. In rifled small-arms, we find pitch varying in degree from one turn in 18 inches, and even less, to one turn in 78 or 80 inches—this, with an even pitch throughout. Further, there are small-arms with a reputation, having a pitch increasing from breech to muzzle. I understand large guns are being rifled on this latter principle.

As regards an increasing pitch, when used in small arms with a projectile of yielding material and fine rifling (which, with this description of pitch, is the best), there is, to a certain extent, I believe, a waste of propelling power, not alone from the continued and increasing resistance offered to the passage of the projectile from breech to muzzle, but also from the continued alteration which its surface has to undergo in order to conform to the continually changing incline of pitch. When the projectile is of unyielding material, I confess I find it difficult to understand how, if it be a male screw fitting any one portion of the rifling, it can be driven along a bore having an uneven spiral without injury to one or both. In mechanics, there is no provision, so far as I know, to ensure harmony in such an ill-matched union. Unquestion-

ably, recoil is diminished somewhat by the lessened resistance offered by slow pitch to the initial motion of the projectile in the bore. Increased pitch *at the muzzle* also gives increased rotation, but it is doubtful whether this high rotation is desirable at the expense of flatness of trajectory.

A pitch decreasing from breech to muzzle was proposed, I believe, long since by Mr. Greener, and I myself have had the curiosity to try it. The results are rather the reverse of those obtained by increasing pitch:—very high initial velocity, but uncertain accuracy of direction at the longer ranges.

To the effects which the direction of pitch of rifling has on the flight of projectiles, I shall refer presently.

With reference to the *manufacture* of rifles, I presume it is known that rifling is formed by planing or scratching away portions of the inner surface of the bore. The instrument employed in doing this is known as a cutter: this is fixed in a cutter-box, *i.e.*, in a cylinder fitting the bore as nearly as practicable; in fact, the cutter is nothing more or less than a planing iron, the cylindrical box in which it is fixed answering to the plane or stock. (I have here a cutter and cutter-box for the Henry rifling.)

This cutter-box, with the cutter, is made by means of the rifling machine to revolve at the required angle of pitch when travelling through the bore, and to shift its position at each cut as required by the pattern of rifle. Now it is evident that this is not a perfect instrument, inasmuch as the exact and uniform action of the cutter on the metal of the bore must depend on the evenness of density and texture of the metal composing the barrel; and it is simply impossible to obtain tubes of even density and texture throughout. Further, the action of the cutter will be influenced by the velocity with which it is made to move through the tube, and by the spring of the rod to which it is attached.

The only attempt at improvement on this system of manufacture has been a proposal to punch or draw the rifling, and to the successful accomplishment of this, the length of tube required to be rifled has hitherto been an obstacle.

I shall now explain the system of rifling alluded to as a novelty in the early part of my paper, viz., "part" rifling. Figs. 8—16.

This system, which is the invention of Wm. Murphy, Esq., of Richmond, Cork, is certainly exceptional. It cannot be said to be rifling of a new pattern, since it embraces every known pattern; nor can it be referred to under the head of pitch, as it is applicable to pitch of any and every degree.

The invention consists in rifling, with *inclined* rifling, only a portion of the bore—a comparatively small portion—towards, or at the muzzle, the rifling being dispensed with in a large portion of the bore in front of the seat of shot, where it has hitherto been an impediment to the initial motion of the projectile, and consequently a cause of recoil. The peculiarity and novelty of the system consist in some measure in confining the rifling, not only to that portion of the bore where alone (as I have proved by experiment) rifling can be necessary, but to the

very portion of it which has hitherto been considered the weakest,—where, in fact, any impediment to the free exit of the bullet has been considered to involve the destruction of the arm.

The inventor claims for his system the following advantages:—First, from the position of the rifling, facility for punching, drawing, or cutting, and accurately gauging the same. Secondly, a great reduction of recoil, without any reduction of charge or increase in the weight of the arm. Thirdly, increased velocity of projectile, and consequent flatness of trajectory, without any loss of accuracy of direction. And, though last not least, a very considerable reduction in the cost of manufacture, with more exact evenness of pitch and form of rifling, consequent mainly on the small portion of bore that will be rifled.

Mr. Murphy contends that the fact of the surface of the projectile having to travel along the incline of the rifling towards or near the muzzle, only, retards slightly, without unduly checking, the velocity at that point, and that, in consequence, a larger quantity of the powder charge is consumed, and a somewhat greater power thus finally applied to expel the projectile from the bore than with the ordinary rifle.* In the case of this latter, the increasing velocity of the projectile is unimpeded, save by the column of air in the barrel, until it escapes from the muzzle, except when increasing pitch is used.

In August, 1871, Mr. Murphy placed his invention in my hands, and since that date I have subjected the system to extended trials with many arms having rifling of various patterns and degrees of pitch. My experience with these rifles, which extends to the firing of several thousand rounds of ammunition, enables me to state that the claims of the inventor have been borne out, to an unusual extent as inventions go; and this, too, under the difficulties attending primary hand manufacture, and a supply of ammunition of the most faulty and uncertain description that I have ever used—the only supply open to me.

With a Martini-Henry rifle, bitted out to within four inches of the muzzle, using the regulation cartridge, I have at 400 yards obtained very satisfactory shooting with elevation for 300 yards only. With a barrel rifled on Mr. Murphy's rib system, having the same length of rifling as above, I have, also with the regulation cartridge, at 500 yards got good targets with 400 yards elevation; at 600 yards, with sighting for 450; and at 700 yards with elevation for 550. With a Peabody-Murphy, the trajectory flattens in like ratio as with the last-named arm, as you get further from the target. With a Henry barrel attached to a Westley-Richards breech-action, using the Westley-Richards cartridge (76 grains powder, 480 grains projectile), I have got equally good results as regards trajectory, with extreme accuracy of direction. Lastly, not to weary you with a further account of experiments, I have, with a Navy Enfield, obtained admirable shooting up to 600 yards, but with less gain in flatness of trajectory, owing to the thinness of the metal at the muzzle.

I am happy to see here to-day, some whose opinions on the subject

* I need scarcely remark that in all arms a certain amount of the powder-charge is blown away unconsumed; and this portion of the charge Mr. Murphy claims to utilize.

of fire-arms must be considered of the highest scientific value, who were present on some of these occasions, and to whom I feel I may confidently refer as to the success of the system. An invention which contradicts so much of our teaching and theory of rifling, will, I make no doubt, meet with opposition; but I have every confidence that when the principle is known, and the system fully and fairly tested, this arm will find its place.

I cannot hesitate to express my conviction—a conviction founded not on theory, but, as I have said, upon extended practice—that rifling barrels all through, from the seat of shot to the muzzle, is, for all the advantages that rifling is intended to secure, unnecessary, and simply a waste of time, metal, and labour—which means money.

I have now arrived at the last division of my subject, viz., the effect which each pattern of rifling and degree of pitch has on the velocity of the projectile, and on the arm with regard to recoil, &c., &c.

What I have already said under the head of pattern leaves but little for me to add regarding it. I would, however, make one or two remarks founded on late practical experience.

In the first place, independent altogether of the weight of the projectile and the resistance offered to its initial motion in the bore, the pattern of rifling—when the bore is rifled throughout—has, in itself, some influence on recoil. Coarse rifling, as well as sharp pitch, offers resistance to the rapid expansion of the product of the powder-charge. As in the case of the projectile, so with the powder-charge, the coarser the rifling and sharper the pitch, the more decided the resistance. With barrels rifled with coarse rifling and sharp pitch, I have found perceptible recoil even when using blank ammunition closed only with a wad. This recoil I could not detect so clearly in barrels with finer rifling and slower pitch, fired under precisely the same conditions as regards ammunition and weight of arm.

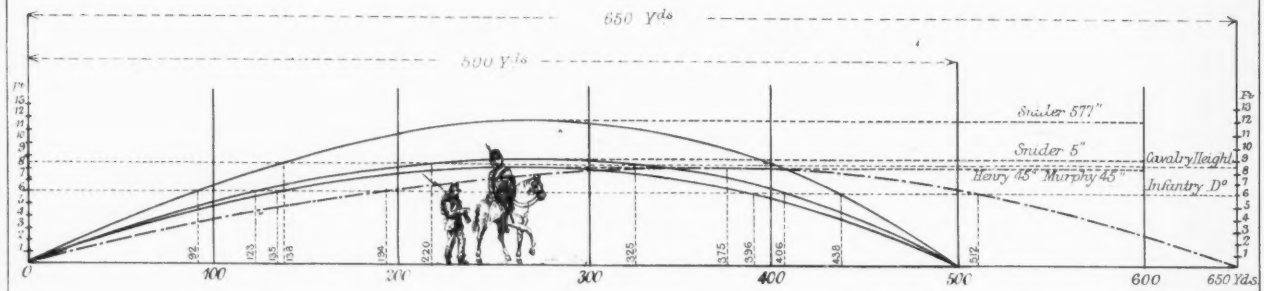
With reference to the pattern of rifling adopted by the Government, I prefer the nine to the seven rifled Henry barrel, not alone because the rifling is of necessity finer, but because I have had somewhat more even practice from it. The pitch, nevertheless—one turn in eighteen inches—is objectionable, as it occasions recoil.

The pitch of screw in rifled barrels is, I contend, about the most important part of the manufacture; for on the incline of rifling depends, in a great measure, the value of the arm as regards velocity and its results, *i.e.*, flatness of trajectory, &c. It is impossible that a bullet can spin with high rapidity, and at the same time travel with high velocity. Rapidity of rotation takes from velocity of progression. Therefore, the slower the pitch, consistent with steady rotation to a *defined* range —all other conditions being equal—the higher can be the velocity; and the higher the velocity, the flatter the trajectory and the shorter the dangerous space (that is, our "catch and graze"). I go further, and submit that comparatively slow rotation, with medium velocity, increases with every increase of the velocity; therefore, in a rifle, accuracy, lateral as well as vertical, can be obtained by velocity.

I need not impress on this professional assembly the advantage of

TRAJECTORIES OF

SNIDER ·577" & ·5" HENRY ·45" & MURPHY ·45" BARRELS.



	Snider 577" Bore	Snider 5" Bore	Henry 45" Bore	Murphy
Safe Distance Cavalry	138 to 400 yds	220 to 325 yds	nil	650 yds.
D° D° Infantry	92 to 438 yds	123 to 406 yds	135 to 396 yds	
Highest point of Trajectory	11 ft. 10¾ ins.	8 ft 10¾ ins.	8 ft 1¾ ins.	8ft. 1¾ ins.

J Jobbins.

flat trajectory in a military arm. Such a trajectory—say extreme height of curve above the level of the ground six feet in as many hundred yards—facilitates the training of the soldier, as it renders instruction in judging distance an easier task, if not altogether unnecessary. Moreover, it does away with the use of the complicated elevating scale or back-sight; to train the recruit in the use of which, requires time. To adjust this sight for use also takes time—time which, I much doubt, a soldier, no matter how well-trained, would bestow in the hurry and excitement of firing in action, or when an object suddenly offers as a mark. An elevating sight of one *leaf*, or at most two *leaves*, ought, with a trajectory such as I have named above, to be sufficient for accuracy up to 600 yards.

A sportsman, when following large game, would not think of using a complicated elevating sight, for, while adjusting it, his opportunity would be lost. The efforts of every manufacturer of sporting rifles are directed to securing the advantage of a flat trajectory to the longest range. But, strange to say, among the numerous expedients resorted to for attaining the desired end—such as large powder charge and light projectile, &c.—a slower pitch of rifling, with powder charge of suitable combustion, does not appear to have had adequate trial.

I am not aware that the extreme range at which our military rifles are, in the hands of the soldier, expected to be practically effective, has yet been clearly defined. I cannot suppose that the extreme range to which the rifles of the present day are sighted, namely 900 yards for the Snider and 1,300 for the Martini-Henry, can be seriously considered practical for troops. A man at 800 or 900 yards is not so good a mark as a quart bottle would be at 150. And, taking into consideration the time a bullet takes to travel the longer distance, and the obstacles to accuracy it has to encounter in its passage, I think you will agree with me that the chances of striking the bottle would be much greater than of striking the man.

It appears to me, therefore, that the first thing is to determine the really practical range for accuracy required in the military rifle; and the arm giving the flattest trajectory to the specified range must be the best—convenience to the soldier with reference to recoil, weight of arm and ammunition, being duly considered.

The *direction* of pitch is also of much importance in rifling. In our military arms of the present day, the pitch of rifling, the pull of the trigger, and the recoil of the arm, are all to the right, and are consequently incentives to error of shooting to the right. I presume it is known here that our military small arms are accurately sighted, as regards *direction* but for *one* range, viz., for 500 yards. The result is, that the sights, as placed on the barrel, are not vertically true with the axis of the bore; and, as a consequence, the sighting for every range, except 500 yards, is more or less inaccurate. In hand rifles, to use an old term, no allowance is made for the drift due to spin of projectile, or "*dérivation*." *Drift* there is in small arms as certainly as there is "*dérivation*" in large guns. I would therefore suggest that, so long as the military rifle is fired from the right shoulder, the pitch of rifling should be reversed, that is, should run from right to left; and that the

sights of the arm should be placed vertical with the axis. Thus the "*dérivation*" would be counteracted by the pull of trigger and the recoil, and the sighting—which would be true to the axis of the bore—would be correct for all ranges. I speak from experience, as in many of the arms I have used, and especially with Mr. Murphy's system of rifling, the pitch was a left pitch. In proof of what I state, I found when firing from the shoulder that the pull of trigger had the effect of correcting the *deviation* due to spin to a greater extent than when fired from a rest.

Apart from pattern and pitch, there are several points in the manufacture of the rifled barrel which are much overlooked, and which claim more than a passing remark. In the first place, the thickness and evenness of the metal round the bore at the muzzle have great influence on accuracy generally, but particularly on trajectory. It is the regulated custom to have the metal of the barrel at the muzzle slight, in order, as it is stated, to make the rifle lighter to carry, and easier to take aim with. This is a fallacy, and sacrifices both flatness of trajectory and general accuracy. The rifles of our forefathers were formed on a truer though rougher principle, as the old rifles on the table prove. The more even the thickness of metal from breech to muzzle, the more even its expansion, and the more accurate the shooting of the arm. I have obtained from rifles, particularly those on Mr. Murphy's system of rifling, *different degrees of flatness of trajectory according to the thickness* of metal round the muzzle. The stouter the metal, the less its expansion, and the flatter the trajectory.

The metal at the muzzle should be of even thickness all round, in order to give even pressure and expansion: this is a point of no slight importance in the manufacture of rifle barrels.

Slightly easing the rifling immediately inside the muzzle, is also an aid to accuracy, since it allows the bullet to slip away with ease from the bore at that particular point. Nipping the bullet at the muzzle is certainly a cause of inaccuracy: I have here a barrel which gives proof of this in a remarkable degree.

Again, the fewer and smaller the lumps or blocks of metal fixed to the outer surface of the barrel, the more even will be the expansion throughout. The Chassepôt barrel would be far more accurate but for the block for the sword-catch, which compels a counter-balancing block on the opposite side. Moreover, brazing on blocks of metal for the sword-bayonet, or for the sights, causes injury to the bore, particularly if the barrel is slight. This is a fact well known to barrel manufacturers. In proof of it, I have two barrels here. In one, the interior of the barrel is imperfect under the block for the sword-catch; in the other, it is injured under the foresight. For the above reasons, I would suggest that the block of the foresight should be placed more than the length of the projectile from the muzzle of the arm.

Bands on a barrel are also, if I may venture to say so, detrimental to even expansion, and consequently to accuracy. To all who use a divided stocked arm, this must be evident. The bands, as well as the half-stock, of the Martini-Henry have to be pinned, in order to prevent their being carried away over the muzzle by the wave of metal

consequent on the passage of the bullet up the bore; and, besides, this fastening on necessitates the fixing of an additional lump of metal on the surface of the barrel.

Lastly, I would say a few words about fouling in rifle barrels. Rifling, as I have already stated, was originally adopted as a receptacle for fouling, and, though in latter days used for the different purpose of rotating the bullet, it must and does continue to harbour fouling. It was to facilitate the clearing out of this refuse, that wads, patches and other expedients were tried, and paper wrappings first proposed, —if I am not mistaken, by General Boileau.

By leaving the greater portion of the barrel smooth, on Mr. Murphy's system, the area of drainage for deposit of fouling is reduced, and the facility for clearing it away largely increased. However, I maintain that on the *cartridge* mainly devolves the duty of removing the fouling; and the smooth bore affords increased facility for this. Unfortunately, the description of cartridge I have been compelled to use, is not the most efficient in this respect. Nevertheless, I have fired more than 100 rounds per barrel at a time, from nearly all the barrels converted on this system, without cleaning, and without having a strip, or failure as regards vertical accuracy. Of course, when I first commenced testing this system, there were failures, and bullets left the bore without taking the rifling.

In concluding my paper, I would state that I shall feel amply rewarded for any trouble I may have taken in putting it together, if it throws a new light of any value on the subject of rifles and rifling.

Commander W. Dawson, R.N.: I would venture to make a few observations on the system of "part" rifling. It was about 18 months' ago, when I began the scientific study of the rifling of great guns, that one of the chief artillerists of the day advised me to make the acquaintance of Captain O'Hea, inasmuch as, he said, Captain O'Hea knew more about the principles of rifling than any man alive. I got an introduction accordingly, and since then I have been in communication with Captain O'Hea from time to time, during the progress of his numerous and varied experiments, and he told me the marvellous progressive results which he successively attained. These experimental results appeared to me so marvellous that they cost me a great deal of study and thought to understand their why and their wherefore. It does appear at first sight very marvellous that taking almost the whole of the rifling out of any rifled small-arm, and leaving only from three to four inches at the muzzle, should produce a very low trajectory without any diminution of accuracy. A week or two ago I went to Wormwood Scrubbs and found a wheelbarrow full of different kinds of hand rifles, including amongst others the Martini-Henry, the Snider, the Westley-Richards, and the Murphy rifles. Every one of them was treated on the same "part" plan, the rifling being taken out of their barrels, except about three inches at the muzzle. A skilful volunteer marksman came on the field who had never seen one of these pieces before, and did not know anything at all about the "part" system. I stood by while he fired at 400, 500, and 600 yards, and I noticed the great diminution in the height of the sights. For instance, at 600 yards, the sight was raised for about 450 yards. And I found that this marksman was particularly struck with the small amount of recoil,—that whereas with an ordinary rifle his shoulder would have felt a very severe recoil, with these "part" rifles the recoil was very small. As to the accuracy of the piece, it was not possible to form a conclusive opinion, as it was a very windy day, but there was nothing to indicate that accuracy had been sacrificed in the slightest degree. What struck me as very marvellous was that in the course of a day's firing, with so many varieties of "part" rifling, there was not a single strip; I expected to have seen some

strips, for the ammunition was exceedingly bad, independently of the novelty of the "part" system. I have been greatly interested to discover the cause of the success of this "part" rifling. It has always appeared to me that like conditions must produce like results, whether in a small arm barrel, or in a great gun. If the results be different, it is clear the conditions must be different. I was, therefore, very much puzzled to discover wherein the conditions were unlike, which produced such apparently diverse results;—for example, to divine how it was that this part rifling at the muzzle produced a lower trajectory, which means a higher velocity and less recoil, while an increasing spiral in the great gun produces a much lower velocity, and higher pressure than an uniform spiral. The two conditions clearly cannot be the same if the results be so opposite. I investigated the point rather closely, to try and discover wherein the difference lay. Experiments made with great guns shew that nine-tenths of the velocity is obtained in the passage of the shot up the barrel before it has reached half-way out of the bore; and the hand rifle being so much longer in proportion to its calibre, nine-tenths of the bullet's velocity would be obtained long before it has reached half the length of the barrel in small arms. That being the case it is plain that any resistance offered to the shot before it reaches half-way up the barrel, must have a most objectionable effect on the velocity. But in the Murphy system of part rifling, the shot is not checked by friction or resistance, whilst attaining that nine-tenths of its velocity, which would, in consequence be much higher than the maximum velocity in other systems of rifling. The maximum velocity is then very much greater in the "part" rifling at the muzzle than it otherwise would be, and there is very little of the increment of velocity thus gained, subtracted by cutting the grooves in the outer surface of the bullet in passing over the four inches of rifling at the muzzle. In the case of the increasing spiral in heavy ordnance, which gives "decidedly the lowest velocities" the opposite condition obtained. The increasing spiral begins to operate directly after the shot leaves its seat, and it applies an ever-increasing resistance to the shot during its passage along the bore. It is a familiar incident known to all sailors that a ship going at full speed may run on a mud bank, and be brought to a dead stand-still by the gradual resistance of the recoil against the ship's bottom, without any one on board knowing of the occurrence. Similarly a ship like the "Devastation," of 9,000 tons, proceeding at full speed, might easily be brought to a standstill, with a rope of three or four inches in diameter, if it were only payed-out gradually, with a steadily increasing strain. It is an ever-increasing range, and an ever-increasing resistance in the form of air which brings the highest velocity shot to a stop at the end of its range, and an ever-increasing force applied to any body in motion will bring it gradually to a stand-still, very much in the same way that the increasing spiral causes the great gun so rifled to have "decidedly the lowest velocities." There was another circumstance in connection with Captain O'Hea's numerous and varied experiments which puzzled me not a little, which was this: Under this system of "part" rifling there is very little recoil. Now it is found in a heavy gun that when an elongated iron shot is fired, the maximum powder-pressure in the chamber (which is represented by the recoil in small arms), is very nearly as great if the cylinder be unrifled as if it is rifled with two studs. The conditions, however, are not alike. When an unrifled iron cylinder is passing out of a heavy gun its body is resting on the bottom of the barrel, and obstructed by the fouling matter in front of its lower side, and there is a great space of windage above it as the shot is not centred. The essential part of all rifling is that the shot should be centred; that is to say that the axis of the shot and of the barrel should correspond. And with reference to a statement made by Captain O'Hea, as to centring, I may say that Captain Scott's is not the only system which centres its shot, although in my judgment he centres it in the best way, that is to say with the least strain upon the gun and projectile, and the greatest windage. Whitworth and Lancaster also centre their shot. All good artillerists aim at centring their projectiles, but they arrive at it by plans of different degrees of excellence. Centring the projectile is considered essential by all practical artillerists. Where there is no rifling at all in the iron cylinder there cannot be any centring, and, therefore, there is an oblique movement in the barrel which offers resistance to the escape of the shot and gives it a wriggling or wobbling motion in

the bore, and then the shot, scraping against the bottom of the barrel, meets a further resistance which tends also to increase the wobbling motion, and the powder-pressure behind the shot accumulates almost as high and as irregular as if the shot was balanced in unstable equilibrum upon two studs nearly under its centre of gravity. But in the case of the small-arm barrel the paper round the bullet keeps the centre of the bullet practically in the centre of the piece and takes away whatever windage would otherwise be above the bullet, so that during its passage along the smooth part of the barrel there really is no "oblique movement of the axis" or wobbling motion. In the ordinary smooth-bore small arm, there are, therefore, different mechanical actions and different conditions from the smooth-bore great gun, both firing elongated bullets. In the smooth-bore small arm with elongated bullet, wrapped in paper, there is very little friction and no oblique movement to diminish the velocity, and by the time the shot has arrived half way up the barrel, nine-tenths of the maximum velocity is attained with the least amount of obstruction, and the increment of stored up force thus gained enables it to overcome the resistance suddenly placed upon it at the end, without an equal decrement of velocity. That appears to me to be the natural explanation of the difference between the high velocities of part rifling and the low velocities of increasing spirals, and between the small recoil or low powder-pressure of part rifling, and the high pressures in Woolwich ordnance. It struck me in thinking over this question of the recoil that there ought to be, if there is not, some way by which the recoil of small arms could be scientifically measured. My own notion is that if there were such an instrument of sufficient delicacy of measurement invented, it would be found that without any bullet at all in the bore, but firing the same sized powder charge, there was a different amount of resistance due to diversities of the pitch and of the coarseness of the rifling, quite independent of the presence of the bullet. If, then, bullets were employed it would probably also be found that different systems of rifling and angles of twist gave different degrees of recoil, and that in proportion to the severity of the recoil would be the height of the trajectory, that is to say, the diminution of the velocity. Strange as it seems at first sight, yet so it is, that whenever the pressure within the powder chamber is highest, there proportionately the velocity is lowest, showing that the high powder pressure arises from the extra resistance offered to the exit of the bullet. The only one of the diagrams before me which I am inclined to cavil at is the iron shot for heavy ordnance represented by diagram, fig. 16. It has not been explained to-day, but I am not sure whether Captain O'Hea told me that he had actually tried experiments with the iron shot shewn in that figure or not. (Captain O'HEA: I have never tried them.) There has been a controversy between Captain O'Hea and myself, as to the application of "part"-rifling to heavy ordnance being possible. That was the only point on which I was prepared to offer anything like an adverse criticism. But the remarkable points that impress themselves on my own mind are these, that the power required to rotate any projectile is exceedingly small, and that it is never that power which injures a gun or destroys it, it is the misapplication of some other power in the unmechanical attempt to rotate it on a wrong principle that does it. It is not the actual power necessary for rotation which injures guns. The smallness of the force required to produce adequate rotation has been repeatedly brought out by mathematicians, and though some of these calculations are based on data with which I do not altogether agree, still the calculations are made by some very learned and clever mathematicians, who prove that the force required to rotate any projectile is a small fraction of the force required to drive it onwards. Another point which also strikes me with reference to Captain O'Hea's numerous and varied experiments is, what great differences in velocity follow from very slight alterations in the mechanical conditions of the rifling, the touch of a file or biting instrument makes 100 yards difference in the range; hence the great importance of studying the mechanical principles of rifling if we would not have "decidedly the lowest velocities" in our great guns. The slightest extra resistance necessarily produces less velocity, even though it brings with it extra recoil or powder pressure within the barrel.

Captain O'HEA: Figure 16 represents a plan for heavy ordnance. The shot is represented as in the bore, in the act of being transferred from the straight, or guiding

rifling on to the inclined, or rotating rifling. It is clear that if the shot were allowed to travel up the bore without a guide, the grooves on it (which are to be filled with lead or other soft metal) may not exactly run, or be truly delivered, on to the inclined rifling at or towards the muzzle; and the consequence might be either tearing of the rifling in the bore or on the shot, or fracture. Mr. Murphy therefore proposes the novel expedient of using straight and inclined rifling, distinct and separate, in one and the same bore, the straight rifles (which may be few) as guides to ensure the hard metal projectile being safely transferred to the inclined rifling, and the shot sent spinning round the longer axis from the muzzle. He also proposes to use a lead-coated shot (fig. 18), or a shot banded on the Vavasour system, to fire from a bore rifled only at or towards the muzzle as shown in the figure 17. This system of rifling heavy ordnance has not been tried. I have not tried it in either case, so cannot speak of it with certainty.

Commander DAWSON: I should like to make a further remark, viz., that there is a vast difference between the proposal for heavy ordnance and what Captain O'Hea has actually carried out with small arms. There is this difference, that whilst this proposal is speculative and prospective, the part rifling in small arms is an actual accomplished fact, and it is to actual accomplished facts that I have been referring, not to prospective speculations. I can see myself what I should think are serious objections to the application of part rifling to iron shot in heavy ordnance, but Captain O'Hea has, by his multiplied experiments, discovered so many marvellous things in connection with our small-arm rifling, that I might possibly prove a false prophet. But one of the objections that strikes one is that in the heavy gun there would be no centring of the projectile until it got near the muzzle, and that in that part of the bore in which it acquires nine-tenths of its velocity, it would be subject to all those objectionable oblique movements of the axis of which I have spoken. That appears to me to be a crucial objection to the proposed application of the system of part rifling to heavy projectiles in great guns.

Captain SELWYN, R.N.: I rise to give my testimony, as a witness of these experiments, which have been to my mind most satisfactory, and I attribute a great deal of the success to the fact of the increased velocity doing away with the necessity for the use of a very sharply inclined spiral. The instant we get increased velocity it means precisely the same thing as increasing the spiral, but without the objectionable features, that is to say, that over the given length of rifling, the projectile has travelled in less time, and has therefore set up a more rapid rotation without encountering the resistance which would have been encountered had that object been obtained by increasing the pitch of the rifling. This system is thoroughly deserving of further experiment, and is one to which Government attention should properly be drawn. It is not one which ought to be left at the charges of a private individual, beyond the point at which Captain O'Hea has arrived in proving it. With regard to its development in larger ordnance, I think a simpler, and probably a more satisfactory mode of accomplishing the same object, at least for field purposes,—how much further, yet remains to be seen,—will be the use of the shot the French are now adopting, with inserted material, soft metal surrounding the hard shot. Copper is generally used as most adapted for the purpose, and we may be quite sure it will behave in anything up to 9-pounder or 18-pounder guns very much as lead would do in the smaller arms. The question of fouling, which is a very important one, will never be satisfactorily decided in my mind (though I have seen no fouling whatever during the days that I have been witness of the experiments) till we have extended experiments in all kinds of weather; for those who have used rifles must know that on a day on which you cannot detect the least atmospheric difference, somehow or other the powder behaves differently in your rifling, and you get hard fouling on one day, whereas on another there is not the slightest trace of it. Therefore even if there should be on some occasions fouling, I should like to test other rifles at the same time to see whether they do not foul also, and to a much greater extent; for I think that in the absence of rifling near the seat of the bullet it will be found that that point of fouling has been entirely obviated. I think of the two kinds of fouling, one near the breach and the other near the muzzle, it will be admitted the most difficult to treat or to do anything with, is that near the seat of the bullet. The one at the muzzle can be very easily got rid of with a little oil and a very small instrument for the

purpose. But we could never manage to remove satisfactorily the lead deposit and the hard fouling which generally occurs at the lower point, without much more delay and more elaborate appliances. As regards rifling, I have myself given a good deal of attention to the different forms of rifling, and I must say, as far as I can yet ascertain in small arms, it remains, as Captain O'Hea has described it, a matter of fancy. You may have fine rifling advantageously opposed to coarse rifling, but as to the form of the rifling there are as many opinions as rifles, and, except that I demur altogether to anything like hexagonal rifling, because it involves a peculiarly fitted projectile, which would involve a peculiarly fitting cartridge in small arms, and which again would prevent a man readily placing his cartridge in the bore, to a certain extent. Except that rifling, which I think objectionable, I do not know that any of the others are not subjects of fair trial with this system, and I am of opinion that we shall get results very nearly equal to those which Captain O'Hea has stated, from all.

Captain SCOTT, R.N.: I think we gather from Captain O'Hea's paper how very important it is at the present time that we should have further experiments, with the view of ascertaining the best system of rifling. At the time of the later experiments, whether we take those with small arms or with great guns—I allude to those which decided the adoption of the national weapons—our knowledge was extremely limited. It has since that time increased very considerably, and we now have not only the actual results of trials to guide us, but in most cases we have also gained the knowledge of the causes of the failures which have occurred. Captain O'Hea has dealt almost entirely with the small arm. To draw any conclusions from the result of the small arm as to probable results with great guns, would, I think, lead into great error. In the small arm we have a leaden bullet which expands, closes the windage, and goes evenly along the bore; but in the great gun we have an iron shot, which, if it be not centred, rubs along the bottom of the bore, and hence, the pressure of the gas upon its top being very considerable and bearing it downwards, greatly increases the friction. The fouling which lies in the bore adds further to the friction, and thus, in the case of the shot and rifling shown in the diagram, there would be an enormous amount of rubbing before the shot could catch the rib, which, in Fig. No. 16, Captain O'Hea has brought to our notice. But I think, if he will allow me, I can show him that a heavy gun, if rifled as that shown, would not succeed. With one guiding-rib the shot's irregular motion throughout the bore of the gun would tend very much to reduce its velocity. With two ribs, the result would be better, but if the gun had three ribs the shot would be centred at first starting. I think also that the great change from a straight line to taking up a sharp incline near the muzzle would, with heavy shot, cause a very serious strain, and that even altering its movement in the slightest degree would tend to injure the gun. I believe it would be found that if the rifled shot with hard wings were used instead, it would leave the gun with quite as high a velocity as a smooth cylindrical shot, and would probably not put more pressure upon the gun. In the case of the smooth cylinder, the shot being nearly of the size of the bore of the gun, the cylinder would rub along the bottom, and would necessarily, from the friction on its heavy surface, have an irregular motion throughout, combined with an enormous amount of friction from clearing away before it the fouling which lies at the bottom of the bore. But in the case of the rifled shot it would be resting, as it were, upon three edges or rails only, with the whole of its cylindrical portion, clear of this fouling, and, being balanced upon its three long bearings it would run along steadily, and would slip out more easily, and certainly with less damage to the gun than in the case of the cylinder shown in the diagram. The experiments which have heretofore taken place with great guns are misleading, because they have been made with studded shot, for with a studded shot you have this condition, that directly the powder gases impinge on the shot, the rear stud squeezes up, and the heel of the shot strikes against the bottom of the bore of the gun, and consequently the front of the shot is raised; but directly the powder gases are more fully ignited and rush over the shot, down goes the front, and then the shot rubs along the base the whole way. The studded shot is, in fact, scarcely better than a cylinder in respect of this irregular movement, which Captain Dawson showed us the other day very clearly. An article has appeared in the "Philosophical Magazine" as to the pressure upon the studs of the Woolwich shot, showing that the gaining twist commencing with one turn in a hundred (as in our 18-ton gun), and ending, I think,

with one in forty-five, or one in fifty calibres, gives the same equality of pressure throughout the bore of the gun. If this be so, our heavy guns are wrongly constructed, for they ought not to be thicker at the breech than at the muzzle, and every artillerist knows that the more even the external shape of the barrel is, the more accurate will be the shooting, especially after the gun warms. But as our 35-ton guns, instead of commencing at one turn in one hundred and ending at one in forty-five calibres, commence at 0°, it is clear, if the article referred to be (practically) correct, that the guns are made the wrong way, and that we ought to have turned the muzzle round, so that the muzzle should be the breech and the breech the muzzle of these guns. I hope you will pardon me for taking up your time, but as this is a question that I have specially studied, and not altogether unsuccessfully as to results, for the Committee allowed in the 7-inch gun competition that although the Woolwich system, or those representing it, obtained the first seat in the couch, they were ready to give me the second. Here is the Woolwich shot, resting as it always does on being loaded in the gun, upon its studs. On the gun being fired the powder gases strike the shot, the studs crush up, and the shot goes down and strikes (with its cylinder upon) the bottom of the bore. The action, therefore, cannot be what the article in the "Philosophical Magazine" appears to indicate, for the shot does not go steadily ahead, but on the contrary its first movement is downward and not forward; so that that pressure, instead of being represented by 18 tons on the square inch may actually be 40 or 50 tons on the square inch, which is very much nearer the truth. But what is the condition of the shot when pressed down? If it were possible that I could cut off a barrel and spread before you the mass of fouling which lies at the bottom, you would see that when the shot is forced down on this mass of fouling it must have a tendency to stick to it, for the diameter of the shot being nearly equal to that of the bore of the gun (the windage being only 0·8 inches over its cylindrical portion, it is ·05 only over its studs) the fouling must come nearly half way up its cylinder, and hence when the shot commences to move forward there must be a very great drag along this fouling. Also, when these studs are pressed down a further action takes place, which to many men may be puzzling, especially as the force required to rotate the shot is an exceedingly small one. What is the reason, then, that these studded shots when fired have their studs cut into in such a way? It is not due to the power actually required to turn the shot, but is simply due to this, that the shot being pressed down in the fouling, and kept down by the gas pressing upon it, has to be dragged through this dirt the whole way, and it is the great force required to drag the cylindrical portion of the shot round through the fouling, so as to give it rotation, that actually cuts into the studs, and very often causes them (as we know has happened on several occasions) to slip over the rifling. I point this out to show how very wrong theoretical deductions often are, and how very far they are from the actual results, which, if closely studied, would show us that we have at the present time a very unsatisfactory system of artillery which ought to be at once investigated, so that we may obtain a system in this country which would be at all events up to our present requirements, and on a level with our great mechanical skill. For the same reason we want further experiments on the system Captain O'Hea has so ably shown to have given such extraordinary results with small arms.

Sir WILLIAM CODRINGTON: There are two points to which I wish to refer. I understood a gentleman near me to mention that in that part of the bore which is smooth, before it comes to the few inches of rifling, there was a rotatory motion given to the bullet. (Captain SELWYN: No.) That is not then the case. There is another point with regard to the bullet used in the Whitworth rifle. I understood it to be asserted that it was necessary to have a hexagonal form, for the purpose of fitting the hexagonal rifling, whereas my impression is, having seen experiments with it, that a cylindrical lead ball was put into the barrel and took the Whitworth rifling.

The Earl of LAUDERDALE: With regard to Whitworth's rifle, I have always been under the impression, that both his shot for great guns and for small arms were cast in the same mould as the form of the rifle.

Sir WILLIAM CODRINGTON: I saw a number of experiments with the Whitworth. A cylindrical bullet was tried against the Enfield in those days. That

certainly was a cylindrical bullet put into the hexagonal barrel with which we had many experiments at Woolwich, and with it I remember the Whitworth made a target at 1,400 yards, when the Enfield could not make one at 1,000.

Captain O'HEA: With regard to the part of my paper having reference to the centring of the shot in large guns, I admit that my not mentioning that there were other systems besides Captain Scott's which accomplished the centring of shot, was an oversight consequent on the haste with which my paper was written; but I scarcely think other systems centre as perfectly. As regards the Whitworth, Sir William Codrington is quite correct; there has been remarkably good shooting made with the Whitworth barrel using the cylindro-conoidal projectile; but to use this form of bullet with anything like efficiency in the small arm, a wad—a specially composed wad—either attached to the projectile, or intervening between it and the powder charge, has to be used. (Sir W. CODRINGTON: This is waxed?) A wax or composite wad. My object in speaking of it was simply to point out that to expand the cylindrical bullet into the polygonal rifling you have to expend more powder power on it than would be the case if the form of the rifling were nearer the cylindrical form of the projectile. The distance between the angle of the polygon and the cylinder is considerable, and the powder-charge is compelled to expend, or waste greater power in expanding the cylindrical projectile into the polygonal rifling than if the pattern were finer.

Sir W. CODRINGTON: I only wanted the fact to be made known. I am not competent to discuss the other question in the least; not that I object to Captain O'Hea's explanation.

The CHAIRMAN: Before closing the discussion I would wish to make a few observations—first, as regards myself, and secondly, as regards the gallant Officer who has given us this very interesting lecture. I should not have made any reference to my own connection with rifling, if Captain O'Hea had not introduced my name into his paper. We all know that great minds jump together, and it happened at the very time Captain Scott was engaged in designing his form of grooving for heavy guns, I was occupied on the very same subject, in the year 1860, in designing a groove for small arms, and we both arrived at almost identical results! Since 1860 I have made twenty-five to thirty rifles for my own satisfaction and the use of my friends, but I never came forward publicly, further than having presented to this Institution, in 1861 or 1862, three rifles with my pattern of grooving. I have brought here specimens of several of my rifles, and this one (selecting the Spencer) represents most perfectly the principle on which my grooving is formed. It is simply a groove, every portion of which tends to turn the bullet, and therefore it is to some extent the same as Captain Scott's. Two of these pieces of barrels, which I hope gentlemen present will inspect, are what I call perfect specimens of rifling. You cannot see the difference between the cylindrical portion of the barrel and the portion of the grooving. The other one I have brought purposely, because it shows in tint the difference; the boring of the barrel is somewhat coarse, and the rifling is beautifully fine, and you can trace the line of separation between the two by the difference of colour.

I wish also to explain the fact which Captain O'Hea has referred to—viz., that the papering of bullets in breech-loading cartridges is the result of observations of my own. I certainly did make those observations in this Institution, in a discussion which was taking place on rifle cartridges, and also at the Society of Arts; and the occasion which gave rise to the remarks was the practice of some amateurs at Kilburn, who brought cartridges of which the bullets were simply coated with black lead. In the course of six or eight rounds the fouling was so great that we were obliged to leave off shooting, and a gentleman asked me for some of my bullets. I made him 300; he went over to Belgium, and he would have had as many more as I chose to give him. The difference between my bullets and those he was using was simply that mine were papered and greased, while the others were coated with black lead.

I went with Captain O'Hea on Tuesday last to Wormwood Scrubbs, where I found, as has been said, a barrow full of rifles. I tried a Martini-Henry of the Government pattern, a Westley Richards of the same construction, one of Murphy's, and one of Peabody's; the rifling in all having been bored out from the breech to within

3 or 4 inches of the muzzle. We commenced practice—(I say we, because I took turn shots with Captain O'Hea)—at 400 yards, and ended at 700 yards, and the results were precisely as he has stated in his paper. At 400 yards we had an advantage of nearly 100 yards in the sighting; at 700 yards an advantage of 150 yards; and the close of our experiments was, that firing at 700 yards, my three last shots were two centres and a bull's-eye; and I did not feel that it was necessary to go beyond that. There was no strip; we fired 75 rounds, and I am as satisfied as it is possible to be from experiment, that this is a very great invention; that it is one eminently worthy of the countenance of Government, and that it should be continued beyond the range to which Captain O'Hea has been able to go, because we have a progressive improvement from 400 to 700 yards, and I have no doubt whatever as the range increases, the advantage will increase. I certainly agree with the two last speakers (Captains Selwyn and Scott) that this is a subject eminently worthy of the attention of Government, and I hope in any experiments that the authorities may sanction, they will not omit to associate Captain O'Hea with their Committee.

In conclusion, I think I may offer to our gallant and talented friend your best thanks for his lecture, expressing the hope that the subject which he has brought before us may be as successful as others of a kindred character on which lectures have been given in this Institution at times when it has been my good fortune to preside. I allude to Sir Wm. Palliser's shot and guns, to Moncrieff's gun-carriage, and to the muzzle-pivoting carriage.